POWER

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How's Business?

IS THERE any physical reason for the condition of depression that we have been passing through for a year or more?

No plague or pestilence has decimated our ranks. No upheaval has produced more than local disaster. Our natural resources are still sufficient for our every need. The soil responds generously to the arts of husbandry. We have the man-power to produce all that the race requires and more tools and machinery than can be used to advantage in its production.

Why then should anybody be idle, destitute, hungry or despondent?

We are such marvels of intelligence in administration that an abundance of workingmen, plenty of cheap power, labor-saving machinery, bounteous crops, ingenious processes and effective production are decried as embarrassments, and drought, disaster and destruction are hailed as measures of relief.

How much of the present condition is physical and inevitable and how much is psychological and avoidable by humanly possible manipulation of controllable factors?

And who knows how to work the controls?

One thing is obvious. Any stinting on ordinary expenditures, any manifestation of niggardliness, parsimony, apprehensive hoarding, will only aggravate the trouble, while wise and judicious expenditure will help to correct it.

In the power plant field advantage is being taken of this season of comparative inactivity to make needed revisions, extensions, overhaulings and repairs, with the effect that most manufacturers of and dealers in power plant apparatus have felt the pinch less severely than those in other lines.

There is plenty of money available at low rates for such forward-looking expenditure and when the recovery comes those who have perfected their facilities under these favorable conditions will be able to turn out power and product at an advantage and to collect a generous dividend upon a timely investment.

And they will have done their bit toward bringing the hard times to an end.

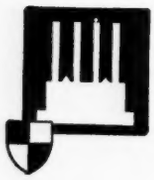
Trained observers profess to believe that we have passed the low-water mark. Traders buy only enough on a falling market to keep themselves going while they wait for further falls in prices. On a rising market they buy in quantities to avoid the coming rise.

Retail buying has kept up fairly well. Buying for stock is off, quite heavily in some lines. When the dealers begin to bring their inventories up to normal, we may look for an improvement.

Let us hope that it is on its way and do what we can to foster a spirit of optimism and helpfulness.

F. R. Low

EDITORIALS



Canada's Economic Combination

CANADA'S DEVELOPMENT of water power is an outstanding incentive to her industrial progress. Having only about eight per cent of the population of the United States, her output of hydro-power is more than half that of her neighbor. A large part of this is produced in regions remote from fuel sources. Even in districts close to the coal fields, water power is utilized extensively. Not only does it supply energy to drive industries but in many cases it provides part or all of the heat for processes.

As a power user, the United States is generally considered to lead the world. In point of quantity this is true, but on a per capita basis Canada outranks us by more than two to one. Furthermore, ninety-eight per cent of her power is generated from water.

With few exceptions, water-power plants in Canada do not operate in parallel with steam plants. The natural flow of the rivers, supplemented by regulating reservoirs where necessary, assures an all year power service. This has been attained with full development of the power sites. The installed hydro capacity is actually thirty per cent greater than the power available half the year on unregulated streams.

The effects of stream regulation are apparent in the high output per unit capacity. In 1929 Canada's central hydro stations delivered three thousand seven hundred and fifty kilowatt-hours per horsepower installed; whereas those in the United States produced less than three thousand.

Some of the largest plants in this country are on well-regulated streams and are connected to systems that can utilize the output continuously. Also, many plants on unregulated rivers are connected to large systems that absorb the output of the hydro plants as available. Notwithstanding these and other conditions in the United States, Canada's hydro plants produced twenty-five per cent greater output per unit of installed capacity.

Electric steam generators are an added influence in the development of Canada's water powers, as they provide load for excess output. Their use has made possible the development of some large projects that otherwise would not have been economical. They absorb large blocks of power for which there is no other market and they are used by industrial plants to improve load factor. While in the United States only a few electric steam generators are in use, Canada and Newfoundland have about one million kilowatts' capacity in service.

Whether or not Canada has achieved the complete solution to utilization of her water power resources, she is to be commended for the progress made.

Another Good Welding Program

THE CONTINUED emphasis laid on fundamental research by the American Welding Society augurs well for the future of the industry and of the society. Research has been well represented on every program in recent years, particularly last year. This week the society meets in Chicago to discuss a variety of subjects, ranging from aircraft to rails and from pressure vessels to stainless steel. Yet this year, as last, the most important thing about the program is its emphasis on fundamentals—research and testing. An entire technical session will be devoted to a symposium on the testing of welds. One paper will deal with fatigue investigations, another with examination of welds by the X-ray diffraction method, another with the magnetic testing of butt welds. These research contributions will ultimately benefit all who are connected with welding in any way.

Engineers in the power field and in certain related fields, such as oil refining, will be greatly interested in the paper on the application of fusion welding to pressure vessels, presented by a representative of one of the large boiler manufacturing companies. It has been known for some time that some of the boiler manufacturers have been carrying on extensive experimental work in welding. Information on these activities will be of great interest and value. Here again the fundamentals are emphasized. Research in welding technique and in the development of non-destructive test methods is laying a foundation of dependability.

New Basic Principles Needed

RECENTLY an English scientist stated that Man is only a mistake and is not so wise as enthusiasts would like to make us believe. This is a challenge to all mankind, particularly to the engineer. There is, however, a certain amount of truth in this scientist's further statement that for the majority of mankind almost the total sum of mental activity consists in imitation or in acquiring and using the common stock of knowledge.

In the power field many of the developments that today are considered most modern in power plant design were thought of and tried generations ago. The advantage of the high steam pressures that are today claiming so much attention were recognized by Jacob Perkins in 1824, and by about the middle of that century he had a triple-expansion engine operating with steam at six hundred pounds pressure and reheating the steam between cylinders. By 1897 De Laval had applied pressures of one thousand two hundred pounds to the steam turbine. That the use of high pressures remained dormant during these intervening years was due to a lack of economic necessity and the absence of materials that would adequately withstand severe steam conditions. Pulverized coal was tried as early as 1824. The furnace water wall made its appearance in the Bettington boiler, and extraction steam for feed water heating was bled from the receivers of early compound engines and later from vertical turbines.

It would thus seem that the modern power plant contains little that is fundamentally new. It is unfair, however, to classify the engineer as an imitator, for his original thinking and inventions have made possible the incorporation of these older fundamental ideas in the modern and efficient power plant of today. Rapid as this development may seem, it does not warrant the engineer's sitting back in his easy chair with the satisfied feeding of ultimate accomplishment. If power plants are to continue to show material improvement, new basic principles must be brought forward.

Middle West Coals

EXCESSIVE moisture, ash and sulphur characterize much of the Middle West coal. Evaporation of this moisture takes heat from the furnace, and there is the subsequent stack loss. Excessive ash interferes with the processes of combustion and heat absorption. If the fusing temperature is low, slagging occurs and causes deterioration of the refractories. Also, molten particles of ash carried up with the gases adhere to the boiler tubes and close up the spaces between them unless continuous effort is made to keep these surfaces clean. The heat absorption rate is lowered, so that high efficiencies and capacities cannot be maintained.

Sulphur plays no favorites, for its effects are evident all the way from the car to the stack and on the equipment carrying away the ash. Even outside a plant the effects of this deleterious agent are evident. Sulphur dioxide in the gases from the stack, combining with the moisture in the atmosphere, forms sulphuric acid. Over modern cities many tons of this acid is precipitated per square mile every year to play havoc with building stone, metals, vegetation and the sensitive membranes of the human body.

For many years the users of these local coals have borne the expense and trouble of combating their undesirable qualities because of the abundance of the supply and the shortness of the haul. The quality has not improved with the years. Such advances as have been made must be credited to the users who have improved the methods of burning and have made it possible to burn lower grades of these coals, although at the expense of maintenance and more costly equipment.

When it is considered that even the freight on the undesirable ingredients in these local coals shipped to the power plants in the Middle West amounts annually to several million dollars, it would seem that some effort should be made to produce a better product.

Other factors being approximately equal, the user will select the coal that gives him the least operating trouble. Successful competition from Kentucky and the East is the proof. If the home market is to be retained and deliveries built up to former tonnage, ways and means of improving the coal must be found. Research to this end is justified.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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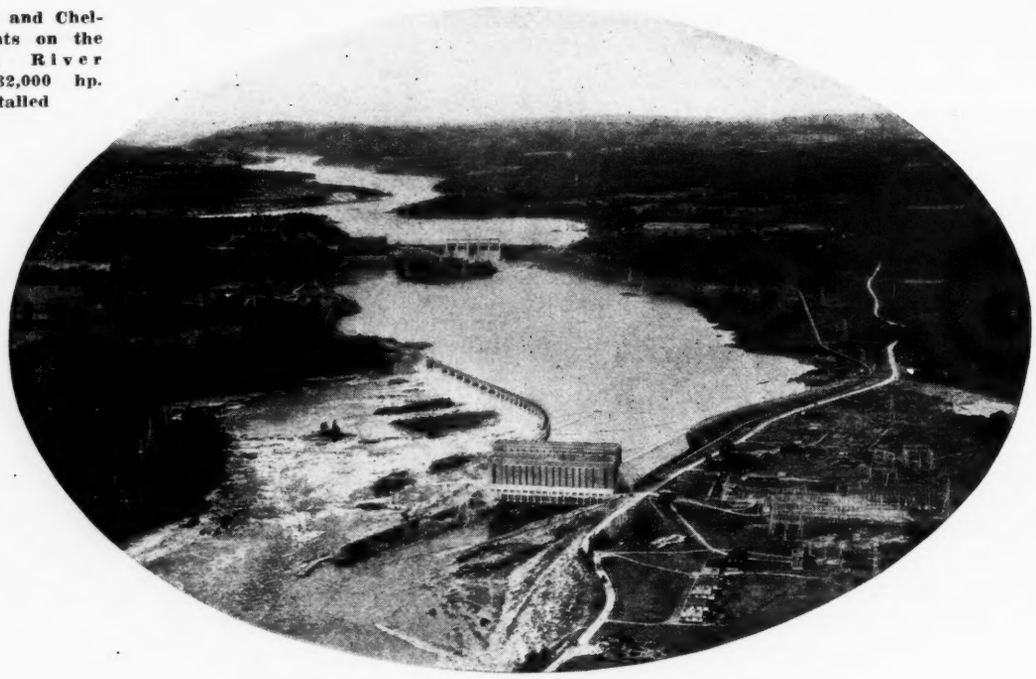


Farmers and Chelsea plants on the Gatineau River have 232,000 hp. installed

WATER POWER Is Building Industrial Canada

By F. A. ANNETT
Associate Editor of POWER

WATER POWER is the vital force in Canada's industrial development. In the pulp and paper industry, mining, metal refining, chemical, textile and in others, water power is supplying the energy not only for driving the machinery but in many cases for part or all of the heat required for the processes. As an example, some of the largest paper mills are operated entirely on electric power. One mill, producing 600 tons of paper per day, uses about 180,000 kw. of hydroelectric power, over 70 per cent of which goes into electric steam generators.

Although Canada's coal resources are poorly distributed, being chiefly in Nova Scotia on the East and in southwestern Alberta and southern British Columbia on the West, her water powers, which are among the best in the world, are favorably located. The table, taken from the 1929 report of the Dominion Water-Power and Reclamation Service, shows the estimated horsepower of Canada's water powers and their distribution. Over 80 per cent of the total is in Manitoba, Ontario and Quebec, those provinces that are farthest away from native coal and have to depend partly upon imported fuel.

The figures for available power given in the table are based upon power sites for which the heads are definitely known or have been well established. There are many falls that have not been studied, and the future will increase the values for available power in the table rather than decrease them. Since the publication of this table, sites have been discovered in British Columbia that will increase the available water power in that province by over 1,000,000 horsepower.

Waterwheel installations throughout the Dominion average 30 per cent greater power than that available at ordinary six-month flow, as given in the table. This would justify an installation of about 43,000,000 hp. of waterwheels. On the basis of the 5,727,162 hp. of waterwheels installed in Canada at the beginning of this year, they represent only a little more than 13 per cent of the then known water-power resources.

The constant flow of Canada's rivers and the possibilities of regulating them at comparatively low cost makes their water powers of unusual economic value. The most important of these powers is the St. Lawrence River. This river is the outlet to the Atlantic Ocean for the Great Lakes system. The tremendous storage capacity of these lakes makes the St. Lawrence flow practically constant. On this river can be developed 5,000,000 hp., of which 4,000,000 belongs to Canada. On account of the constant flow of the river, Canada's share of the power represents over 25,000,000,000 kw.-hr., or about

50 per cent more than produced last year in her central stations. This figure is particularly significant when it is realized that, per capita, Canada is the largest producer of power in the world.

The many large lakes and sites for reservoirs on Canadian rivers make their regulation comparatively easy. Lake St. John, on the Saguenay River, is controlled between natural high- and low-water levels and provides 3,850,000 acre-ft. storage capacity. This river is regulated to a minimum flow of 28,000 sec.-ft. This storage was created by building a 540,000-hp. plant at the discharge of the lake. On the St. Maurice River the largest artificial reservoir in the world is formed by Gouin Dam. It has a capacity of 3,662,000 acre-ft. At Shawinigan Falls the minimum flow of the St. Maurice River has been increased from 6,000 to 17,000 sec.-ft. by the Gouin and other reservoirs. Further development on the St. Maurice River will materially increase its regulated flow.

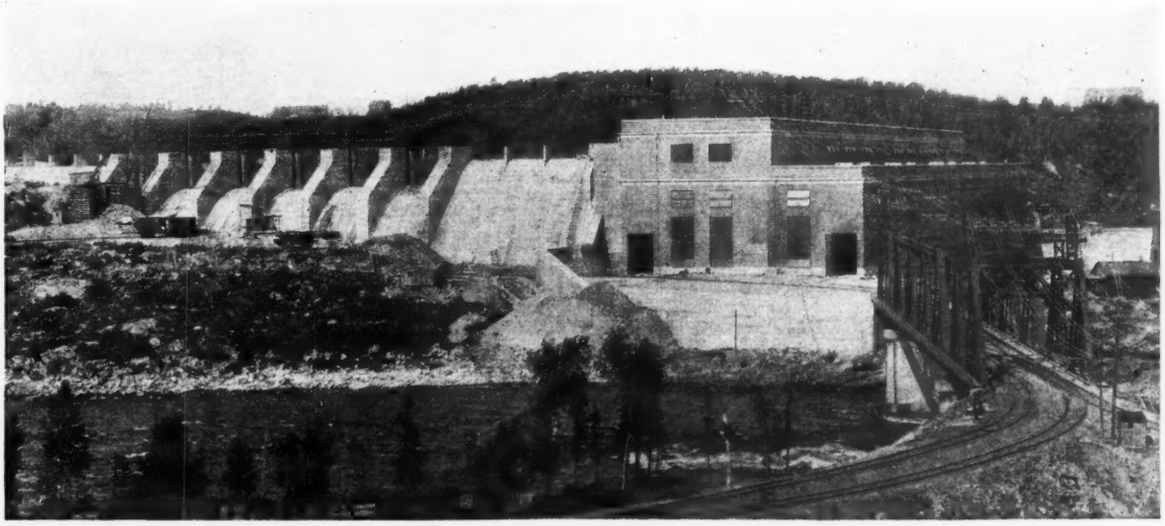
On the Gatineau River, a tributary of the Ottawa, two reservoirs have been formed. One, the Mercier, has a capacity of 2,132,500 acre-ft., the other is Lake Cabonga, with a capacity of 1,033,000 acre-ft. These two reservoirs regulate the minimum flow of the river to between 10,000 and 11,000 sec.-ft. during the lowest flow year. The normal flow of this river before being regulated varied from 2,500 to 72,000 sec.-ft. On the Lievre, another tributary of the Ottawa, a reservoir of 500,000 acre-ft. capacity regulates the flow of that river to 3,400 sec.-ft. Storage reservoirs on the Ottawa and its tributaries have more than doubled its low flow, increasing it from 12,000 to about 25,000 sec.-ft. When the river is more fully developed the minimum flow will be further increased.

The Winnipeg River in Manitoba rises in Lake-of-the-Wood. This lake has an area of 1,500 square miles, and 5.25 ft. of controlled storage on it provides 5,000,000 acre-ft. capacity. Lac Suel, on the English River, a tributary of the Winnipeg, has 3,210,000 acre-ft. additional storage capacity. On the Winnipeg River there are in operation or under construction plants having an aggregate capacity of 600,000 hp. This river connects Lake-of-the-Woods with Lake Winnipeg, and the fall is 340 ft. The latter lake is 715 ft. above sea level and empties into Hudson Bay through the Nelson River. Although no power has been developed on this river, there are large possibilities of regulating its flow by controlling the levels of Lakes Manitoba and Winnipeg, both having large areas for a water storage system.

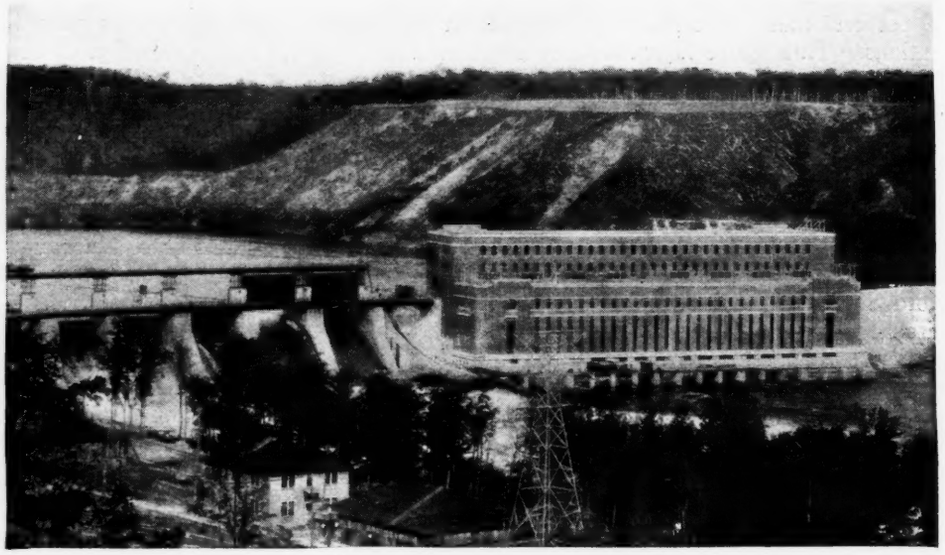
There are many other storage reservoirs in Canada, but the foregoing will illustrate the importance of river regulation in Canada's hydro-electric systems.

Ninety-eight per cent of Canada's power is generated by water. It frequently supplies both the power and heat for industrial processes. Last year, the power generated per capita in Canada was twice that in the United States

According to the report previously referred to, 4,817,486 hp. of waterwheels had been installed in central stations up to the end of last year. It is estimated that about 98 per cent of the total power generated in Canada's central stations is produced by water. These stations last year produced about 17.5 billion kilowatt-hours. For ten million population, this is 1,750 kw.-hr. per capita. In the United States the public utility plants of all kinds generated about 97 billion kilowatt-hours, which for a population of 120 million is 808 kw.-hr. per capita, less than one-half of the per capita power generated in Canada. In other words, if the central stations in the United States had produced as much power per capita as was generated in Canada their output would have exceeded 200 billion kilowatt-hours. This is not a strictly correct picture of power utilization in the two countries, because there are other factors that must be considered. For example, a large part of the industrial heat in the United States is produced by fuel, but in Canada hydro-electric



This plant on the Saguenay River has 495,000 hp. installed and space for one more 45,000-hp. unit



La Gabelle plant of the Shawinigan Water Power Company on the St. Maurice River has four 35,000-hp. units operating and the fifth is being installed. Propeller-type wheels are used in this plant and the head is 65 ft.

power supplies a considerable amount. Nevertheless, these figures show what an important factor water power is in Canada's industrial development.

Coal Equivalent

Including the hydro power owned and operated by industries, it is estimated that 20.5 billion kilowatt-hours was produced by water-power installations in 1929. Applying to this the conservative figure of 1.76 lb. of coal per kilowatt-hour (the average coal consumption per kilowatt-hour for all the public utility plants in the United States), a coal equivalent of 18,000,000 tons is obtained. As a large part of this power was used in regions far from native coal or that have to depend upon imported fuel, the rôle that water power is playing in Canada's industrial expansion is evident. In fact, many of the industries would not have come into existence had it not been for the large water powers available.

Large-Scale Development

Many of the water powers must be developed on a large scale to be economical. They involve not only constructing power stations, but also require creating sufficient water-storage capacity to provide a dependable power supply at all seasons of the year. In addition, a load must be found or created for large blocks of power.

A good example of how this is done is found on the Gatineau River in the Province of Quebec. All the water rights on this river are owned by Gatineau Power Company, a subsidiary of the International Paper & Power Company. There are four major power sites, three of which were developed as a unit. This was made economically possible by entering into contracts with the Hydro-Electric Power Commission of Ontario to supply 360,000 hp. These contracts start at a comparatively small quantity and increase over a period of years.

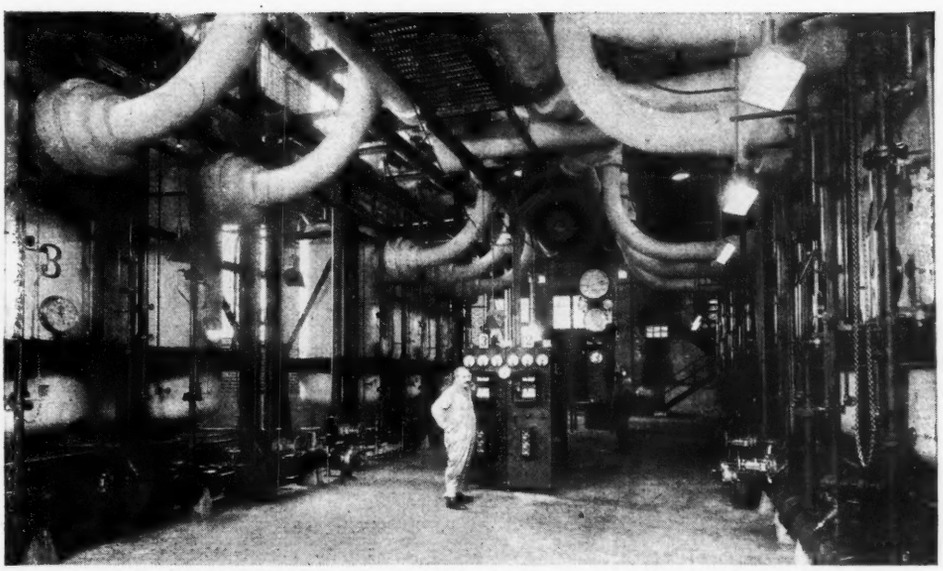
To utilize the power not required by the commission in the early years of the contracts, the Canadian International Paper Company built, near Ottawa, a 600-ton pulp and paper mill to be operated electrically, even to supplying the process steam. To operate this mill requires a maximum of about 180,000 kw., of which approximately 150,000 goes into electric steam generators. At the present writing the demands for Gatineau power to supply industrial loads have increased to where there will soon not be sufficient to supply the paper mill's steam requirements. To provide this steam a large coal-fired boiler plant is being constructed and will go into service before the end of this year. After the coal-fired boiler plant is operating, the electric boilers will be used to absorb any surplus power that may be available.

Three plants have been built on the Gatineau River. The first, at Farmers Rapids, is about 4½ miles from the mouth of the river and 10 miles from the city of Ottawa. Four 24,000-hp. units have been installed, operating under a 66-ft. head. There is space for a fifth unit, which will give the plant an ultimate capacity of 120,000 hp. A mile above the Farmers Rapids plant is Chelsea station, designed for five 34,000-hp. units operating under a 96-ft. head, four of which have been installed.

A third plant, the Paugan station, is 26 miles above Chelsea. This plant is designed for eight 35,000-hp. machines, and the average head is 130 ft. Six of the machines have been installed. The plant is so designed that it can be extended to include a total of sixteen units if it ever becomes desirable to operate on a low load factor. The dam at Paugan backs the water up the river for 30 miles. Thus the three stations utilize the total fall in the river for over 60 miles. At another site on this river 100,000 hp. can be developed. When a plant is built on that site and the others completed to their full capacity the four will have a total capacity of about 700,000 hp. These plants are interconnected with other stations owned by the company on the Ottawa River, notably

AVAILABLE AND DEVELOPED WATER POWER IN CANADA

Province	Available 24-Hr. Power at 80 Per Cent Efficiency: At Ordinary Min. Flow, Hp.	At Ordinary 6-Mo. Flow, Hp.	Turbine Installation, Hp.
British Columbia	1,931,000	5,103,500	559,792
Alberta	390,000	1,049,500	70,532
Saskatchewan	542,000	1,082,000	35
Manitoba	3,309,000	5,344,500	311,925
Ontario	5,330,000	6,940,000	1,952,055
Quebec	8,459,000	13,064,000	2,595,430
New Brunswick	68,600	169,100	112,631
Nova Scotia	20,800	128,300	109,124
Prince Edward Island	3,000	5,300	2,439
Yukon and Northwest Terr.	294,000	731,000	13,199
Total	20,347,400	33,617,200	5,727,162



Electric steam generator plant in the Gatineau mill of the Canadian International Paper Company. In this plant there are three 42,000-kw. and one 21,000-kw. electric steam generators used

those at Byson, with 51,400 hp. installed, and two plants at Chaudiere Falls, with an aggregate capacity of 36,600 hp.

On the Lievre River, another tributary of the Ottawa, the James MacLaren Company, Ltd., owns practically all the water rights. This company has for many years operated sawmills and pulp mills on this river, at Buckingham, Que., about 20 miles from the city of Ottawa. Recently the MacLaren company put into operation a hydro-electric plant designed for 120,000 hp. in four 30,000-hp. units. Three of the units have been installed, and the power is being used in the company's new 250-ton paper mill at Masson, about 35 miles from the power house. This mill is complete with a sulphide-fiber plant and is entirely electric, steam being supplied by four 16,000-kw. steam generators. The same company has recently announced plans to build another 120,000-hp. plant on this river. These two plants are in addition to the MacLaren company's water-power installations in its lumber and pulp mills at Buckingham.

On the Saguenay River, in the Grande Discharge from Lake St. John, is the plant of the Duke-Price Power Company. This plant is designed for twelve 45,000-hp. units under a 110-ft. head. Eight of the units were installed complete, and the penstocks and settings for the other four were installed in the initial undertaking. For a period after this plant was started a large part of this power was used in the Price Brothers paper mills for steam generation. The plant now has eleven units installed, making its capacity 495,000 hp. The large storage provided by Lake St. John makes the river ideal for water-power development.

Below this plant, in the thirteen miles to tidewater at Chicoutimi, there is a fall of 210 ft., where over a million horsepower can be developed. The Alcoa Power Company owns the water rights and has a 260,000-hp. plant nearing completion. This power will be used in plant of the Aluminum Company, Ltd., at Arvida, about 10 miles from the power house. A large part of the power will be used in refining aluminum.

On the St. Maurice River in Quebec, the Shawinigan Water & Power Company has developed 580,000 hp. in its plants at Grand' Mère, Shawinigan Falls and La Gabelle. It also has started work on one of eight other projects on this river. When these are completed they will bring the total waterwheel installation on the river up to over 1,750,000 hp.

The largest single water-power project in Canada, or in the world, is that being made by the Beauharnois Power Corporation on the St. Lawrence River. The development comprises a canal fifteen miles long between Lake St. Francis and Lake St. Louis and a power house designed for 500,000 hp. Ultimately the canal will be 3,000 ft. wide and 27 ft. deep and will supply water to a 2,000,000-hp. plant. Orders have been placed for four 50,000-hp. units complete and the parts to be embedded in the concrete substructure for the other six units. Contracts have already been placed for 400,000 hp. of this power. One is for 250,000 hp. with the Hydro-Electric Commission of Ontario, and another for 150,000 hp. with the Montreal Light, Heat & Power Consolidated.

The large hydro developments are not all in Eastern Canada. In British Columbia the Bridge River project will have an ultimate capacity of about 600,000 hp. under a 1,200-ft. head. The project involves diversion tunnels to take the water from Bridge River, a tributary of the Fraser, and discharge it into Lake Seton, about 50 miles from Vancouver. The first tunnel in this development has been holed through, and it is reported that 80,000 hp. capacity will be in operation in 1932.

In the remote region of Northern Saskatchewan, on the Churchill River, a 90,000-hp. plant has been built for the Hudson Bay Mining & Smelting Company. The initial capacity, 45,000 hp., of this plant is to operate the company's Flin Flon mining operations. Only a few years ago this region was reached only by dog team or over trappers' trails. In Northern Ontario water power is playing an important part in both mining and metal refining and in the pulp and paper industry. For example, the International Nickel Company, through its subsidiary, operates five plants having an aggregate capacity of 63,000 hp. The Canadian Northern Power Corporation operates eight plants and serves the gold and silver mining areas in Northern Ontario. The Abitibi Power & Paper Company, through its subsidiaries, operates several plants to serve its pulp and paper mills and for other purposes. There is now under construction on the Abitibi a 275,000-hp. plant by the Hudson Bay Power Company.

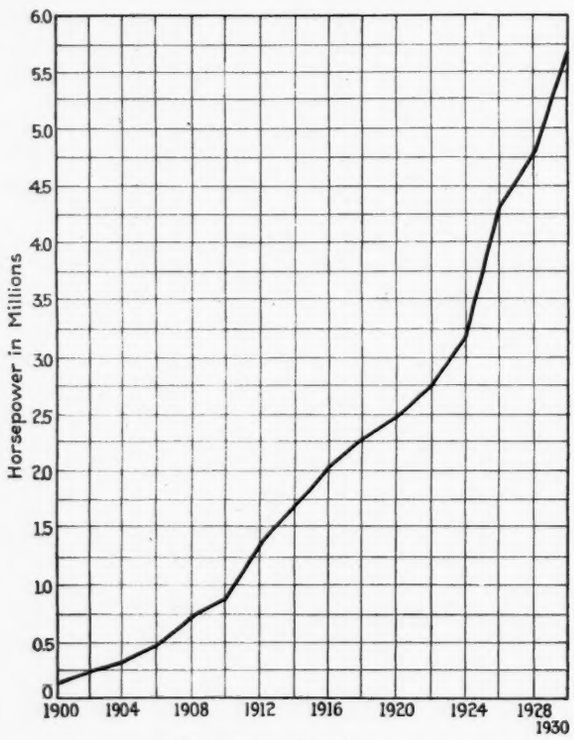
The Hydro-Electric Power Commission of Ontario has contracted for 100,000 hp. of this power. The commission is the largest producer and distributor of power in Canada. It owns and operates 25 power stations

having an aggregate capacity of over a million horsepower and last year sold over five billion kilowatt-hours.

Electric Steam Generators

Electric steam generators have been a prominent factor in the development of Canada's water power. There is now installed in Canada and Newfoundland sufficient steam generator capacity to absorb about a million kilowatts. The most notable of these installations is that in the Gatineau mill of the Canadian International Paper Company, where there are three 42,000-kw. and one 21,000-kw. units to supply the entire steam requirements of a 600-ton paper mill. All of the steam for the Abitibi Power & Paper Company's Pine Falls mill and the new paper mill of the James MacLaren Company is supplied by electric steam generators. Such paper mills as those of Price Brothers at Kenogami and River Bend, the Abitibi Power & Paper Company at Iroquois Falls and the Newfoundland Power & Paper Company's mill at Corner Brook have part of their steam requirements supplied from electric steam generators.

Ordinarily, power cannot be purchased on a kilowatt-hour basis and used to produce steam in competition with coal. However, the revenue obtained from power sold for steam is sufficient to permit developments to be made when a market at commercial rates is available for only part of the output. This has proved to be the case with several of Canada's large water-power developments now in operation. As a commercial market is found for the power at industrial rates the power going into steam is used for this market and the electric steam generator load is taken over by fuel-fired boilers. The electric steam generator is simple, is comparatively cheap to install and operate and requires small space. For these reasons after power is no longer available for their continuous operation they can be used economically to absorb any excess power that may be available. Some of the power companies operate them in this way in parallel with fuel-fired boilers in industrial plants. When there is excess power, such as during high water or over week-ends, it is turned into the electric boilers and sold as steam.



Curve shows growth of water-power developments in Canada

Rapid Increase in Water-Power Developments

The use of water power in Canada is increasing rapidly, as indicated by the curve issued by the Dominion Water-Power and Reclamation Service. At the beginning of 1900 there was 173,300 hp. installed. By 1910 the installed capacity had increased to nearly a million horsepower. In the next 20 years the increase was about 4,750,000 hp. At the present rate of increase, by 1940 the installed capacity will be about ten million horsepower. The mid-year report, dated June 30, 1930, by the Minister of the Interior of the Dominion indicated that water-power developments are more active now than at any other time. Installations aggregating more than 1,680,000 hp. are under active development. Many of these comprise the initial stage only, and when they have reached their ultimate capacity another two million horsepower will have been added to the total installations.

Why Shunts Are Not Used With A.-C. Ammeters

By H. S. Edgerly
Switchgear Engineering Dept.
General Electric Co.

THE QUESTION is often raised as to why shunts are not used with alternating-current ammeters, similar to those used with direct-current ammeters, and thereby eliminate the expense of current transformers. This is quite a natural inquiry and might well be given a little attention for the benefit of those using instruments yet not familiar with the details of design.

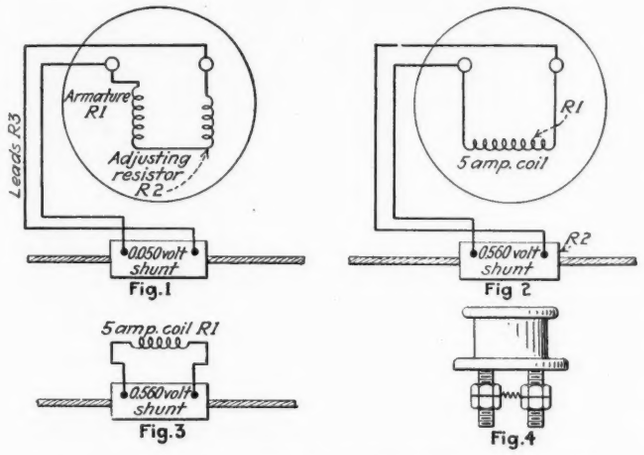
In this article we will assume the ammeter is to be used on circuits rated 650 volts or less. For higher voltages the instrument and leads must have some form of additional insulation to protect the operator. This can be supplied either by protective cover over the entire instrument, limited to approximately 3,000 volts, or by using a current transformer. In the former the leads must be insulated for the line voltage, while with the current transformer standard leads are satisfactory, as the secondary is insulated from the line voltage.

First, it might be well to consider what is being done on direct-current ammeters, so that a comparison may be obtained. A direct-current ammeter operates on approximately 0.02 amp. at 0.050 volts. Fig. 1 shows a conventional ammeter connected to a shunt. The armature R_1 is wound with copper having a resistance of 0.7 ohm. The leads R_3, also of copper, have a resistance of 0.07 ohm, or a total of 0.77 ohm copper in the measuring circuit. The adjustable resistor spool R_2 is wound with 1.8 ohms of a low-temperature coefficient wire (0.000022 on a 25 deg. C. basis). This is negligible, as the change in resistance for this part of the circuit is only 0.02 per cent for each 10 deg. C. change in temperature. Considering the copper part of the circuit as having a resistance of 0.77 ohm, a change of 10 deg. C. in temperature will change the resistance 0.03 ohm. This, referring to the combined resistance of the circuit (0.77 + 1.8), 2.57 ohms, introduces an error in the

indications of the instrument of 1.1 per cent, which is considered satisfactory, as the room temperature seldom varies more than this amount.

On the other hand, if the adjusting spool R_2 were wound with copper wire, making the entire circuit copper 2.57 ohms, the instrument would have an error of 4 per cent for each 10 deg. C. change in temperature, due to the fact that copper has a relatively high temperature coefficient. This variation is not satisfactory for the average installation.

Applying these principles to the alternating-current ammeter, consider a 5-ampere switchboard-type meter, which requires a potential of about 0.56 volt. Referring to Fig. 2, the coil R_1 is wound with copper wire and no additional resistance of low-temperature-coefficient wire



FIGS. 1 TO 4—AMMETERS CONNECTED TO SHUNTS

Fig. 1—Direct-current ammeter connected to a shunt. Figs. 2 to 4—Diagrams of alternating-current ammeters connected to shunts

can be added without materially increasing the voltage drop of the shunt R_2. This would be objectionable, for even at 0.56 volt and 1,000 amp. there would be a loss of 560 watts, or approximately 13½ kw.-hr. per 24-hr. day. The shunt would also be mechanically too large and expensive to be commercially acceptable. In addition, electrical difficulties are encountered.

The coil has a reactive as well as a resistance component, so impedance ohms rather than resistance ohms must be considered. The shunt to which it is connected has only resistance ohms. As the readings of the ammeter will vary with the frequency, it would be necessary to calibrate the instrument for the frequency at which it would be used. An example is given below of the errors that could be caused at a frequency of 5 cycles from that upon which calibration was made. The current in amperes in the meter coil may be obtained by the formula $I = \frac{E}{\sqrt{R^2 + (2\pi fL)^2}}$

Where R = Effective resistance in ohms.
f = Frequency in cycles per second.
L = Inductance in Henrys.

Assume, in Fig. 3, that coil R_1 has a resistance of 0.106 ohm, the inductance of the circuit 0.000207 Henry, the circuit frequency 60 cycles and the drop across the shunt 0.56 volt. This gives a value for

$$I = \frac{0.56}{\sqrt{0.106^2 + (2\text{x}3.1416\text{x}60\text{x}0.000207)^2}} =$$

= 4.2 amp.

Thus at 60 cycles 4.2 amp. would pass through the ammeter with the shunt operating at 1,000 amp. and having a drop of 0.56 volt. Substituting 55 for 60 cycles, 4.37 amp. would pass through the ammeter with the same amount of current through the shunt as in the previous example. It is obvious that this would not be serious for the average circuit, as the frequency is quite constant, but a 5-cycle variation has been selected to show that the instrument could not be transferred from one circuit to another of different frequencies without appreciable errors.

The next logical step might be the suggestion that instead of using a shunt like the one in Fig. 3 a copper shunt having the same resistance as the ammeter coil be connected across the instrument studs, Fig. 4. Here again the difference in impedance would cause a difference in current distribution at different frequencies. This could practically be overcome in design by making the time constant $\frac{L}{R}$ of the coil the same as the shunt. Even then there would be errors due to temperature changes because of the difference in radiation in the coil and shunt. This error would also occur if another instrument coil were substituted for the shunt.

A further disturbance in current distribution would be caused by the contact resistance in mounting the shunt on the studs. For example, the shunt would be mounted and the instrument calibrated, after which the shunt would be removed for mounting the instrument on the panel. Upon remounting the shunt it would be quite possible to have an appreciable difference in the calibration. Experience has shown that for all conditions the best over-all accuracy that can be expected in an external-shunt-operated alternating-current ammeter is 3½ per cent of full-scale reading at any point of the scale, and this might easily increase to 10 per cent or 15 per cent of full-scale reading.

Putting Lighting Circuits Under Remote Control

IT IS generally appreciated that making the control of motors so that machines can be conveniently stopped and started is economical. This saves the operators' time and it also reduces power consumption by decreasing the idle running time of the motors. A motor that can be controlled by pressing a conveniently located button is more likely to be stopped immediately by the operator, when not required, than when the process requires the manipulation of a manual starter some distance away.

The same principle applies to remote control of lighting. By grouping the lighting circuits in suitable divisions and putting each under the control of a contactor, they may be arranged for remote control at small expense. The contactors may be placed where they are out of the way, with push buttons located at convenient points for control of the lights. Or, if necessary, the control may be arranged from several points. For example, the push buttons may be located where those using the light may turn them on or off, with a bank of buttons convenient to some responsible head of the department, and when the lights are not needed they can all be turned off from the central point. Push buttons may be located along the route of the night watchman, so that he can turn on a group of lights where he enters the floor and turn them off where he leaves.

Boiler Exhibits at National Museum Trace 50 Years' Progress

By FRANK A. TAYLOR
Asst. Curator, United States National Museum

THE United States National Museum at Washington has just installed an important addition to the exhibits showing the historical development of the steam boiler. The new material, a gift from the Babcock & Wilcox Company, includes a model of a boiler of fifty years ago, two models of present-day boilers, a series of old and new boiler headers that show the development of this part of a boiler, and a large group of drawings that picture the evolution of water-tube stationary and marine boilers from the earliest types to those of the present. In addition, a small case of original models, photographs and biographical material, describes the part that Stephen Wilcox and George H. Babcock had in the development of the sectional water-tube boiler. The presentation of this material to the Museum comes very appropriately in the fiftieth year of the existence of the Babcock & Wilcox Company and in the hundredth anniversary year of the birth of Stephen Wilcox.

The boiler of fifty years ago is a half-size model of that which won the award for sectional steam generators at the Centennial Exposition in Philadelphia in 1876. This model shows a hand-fired, inclined-tube boiler with two longitudinal drums connected by a cross steam drum. The headers are of the earliest type of cast-steel sinuous header and are seven tubes high. The boiler is partly suspended from two cast-iron arched beams that rest upon the side walls of the brickwork.

Accessories include a ball-and-lever safety valve, three water-level sight gages and a pressure gage. The highly ornamental cast-iron front, so typical of early boilers, is trimmed in gold. The original boiler of which the model is a copy was sold to the DeCastro & Donner Sugar Refinery in Brooklyn, N. Y., after the close of the Centennial Exposition, and was in service until recent years. It is now preserved at the Bayonne, N. J., plant of the Babcock & Wilcox Company.

In rather startling contrast to the simple Centennial boiler are models of two modern types with their many auxiliaries. One is a one-eighth size model of a Babcock & Wilcox double-deck, inclined-tube boiler, with interdeck superheater, air preheater and economizer; and equipped with a Westinghouse underfeed type of stoker. Various parts of the model are cut away to show details of the equipment, such as the water-cooled furnace walls, and all parts are liberally labeled. The second modern boiler is a one-eighth size model of a boiler of the Stirling bent-tube type. This also has a superheater, air preheater, water walls and economizer and is shown equipped with a pulverized-coal furnace.

The series of boiler headers shows the development in the design of the header to meet the changes from the low pressures of the period of about 1867 to the 1,400 lb. per square inch that is used in several plants today. The first header of the series is built up of the cylindrical tube ends that are cast on the ends of the individual cast-iron tubes. These tube ends fit together with machined surfaces, one upon the other, and are held with a long T-headed through bolt and nut. Following this is a cast-steel sinuous header, such as introduced in 1874, which is the type of header that is shown on the model of the Centennial boiler of 1876. Next is shown a marine boiler header of square cross-section designed to provide a better arrangement of the 2-in. marine boiler tubes, which are joined to the header in groups of four. The fourth header is of wrought steel and is designed for 450 lb. It is equipped with inside fitting handhole covers, assembled with gaskets between the machined surfaces of the header and the covers. The final header is of the type used in the 1,400-lb. boilers. It is of forged steel approximately one inch thick.

A group of fourteen hand-lettered cards, illustrated by excellent drawings, review the development of the water-tube boiler and supply additional facts in the history that are not brought out by the other parts of the exhibit. These cards were executed by Edmund Mills, who was in charge of the preparation of the entire display. One of these cards is here reproduced as well as photographs of the models.

Other tubular boilers in the museum collection, not a part of the above gift, include the original steamboat boiler made by John Stevens in 1804; the water-tube locomotive boiler built by John Cox Stevens in 1825; a group of Patent Office models of boilers of miscellaneous design, including some by men as well-known as George H. Corliss; a model of a National boiler of 1885; and a model of the drum type of boiler built by the Erie City Iron Works in 1928, with a Seymour furnace and equipped with a pulverized-coal burner.

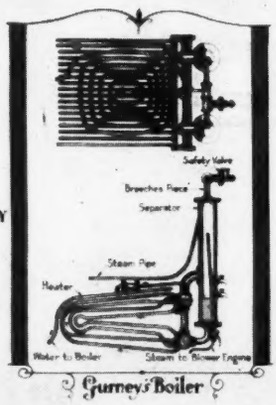
The Stevens steamboat boiler of 1804 is a sheet-iron furnace supporting a combination water drum and steam dome of odd pyramidial shape. A cluster of short dead-ended water tubes projects from the bottom of the water drum into the furnace space. This boiler is believed to be the earliest water-tube boiler now in existence. The peculiar arrangement of the tubes gave rise to the name of "porcupine" for the type of boiler.

The John Cox Stevens boiler of 1825 consists of two circular headers joined by twenty vertical wrought-iron water tubes, the whole tube element being about twelve inches in diameter, mounted over grates in a vertical cylindrical sheet-iron shell. The boiler was used to supply steam to the engines of an experimental locomotive. It was deposited in the museum, with the preceding one, by the Stevens Institute of Technology.

The museum has under construction a small model of the internally fired wooden boiler that was used in the Center Square Water Works at Philadelphia in 1801. This was an elementary form of water-tube boiler.

EVOLUTION of THE STEAM BOILER

1826
GOLDSWORTHY GURNEY



Gurney's Boiler

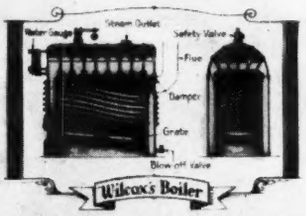
In 1826 Goldsworthy Gurney built a number of boilers which he used on his steam carriages, one of these is illustrated here.

A number of small tubes were arranged as shown, with their ends coupled to larger horizontal pipes. Circulation was established as indicated by the arrows.

There were also two vertical separators which were connected by a breeches piece from which the steam supply was taken and on which a safety valve was placed.

Note that some of the steam generating tubes discharge above the water line in the upper horizontal pipe.

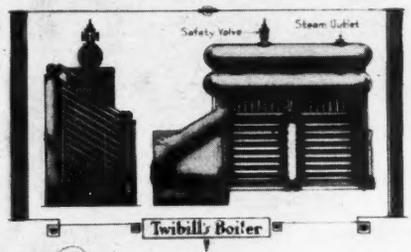
1856
STEPHEN WILCOX
ONE OF THE FOUNDERS OF THE BABCOCK & WILCOX CO.



Wilcox's Boiler

Stephen Wilcox, in 1856 used inclined water tubes to connect water spaces at the front and rear with a steam space above.

1865
GEORGE TWIBILL



Twibill's Boiler

In 1865 Twibill used inclined tubes built into sectional form. He used wrought iron tubes connected at the front and rear with standpipes thru intermediate connections. These standpipes carried the steam to a horizontal cross drum at the top the entrained water being carried to the rear.

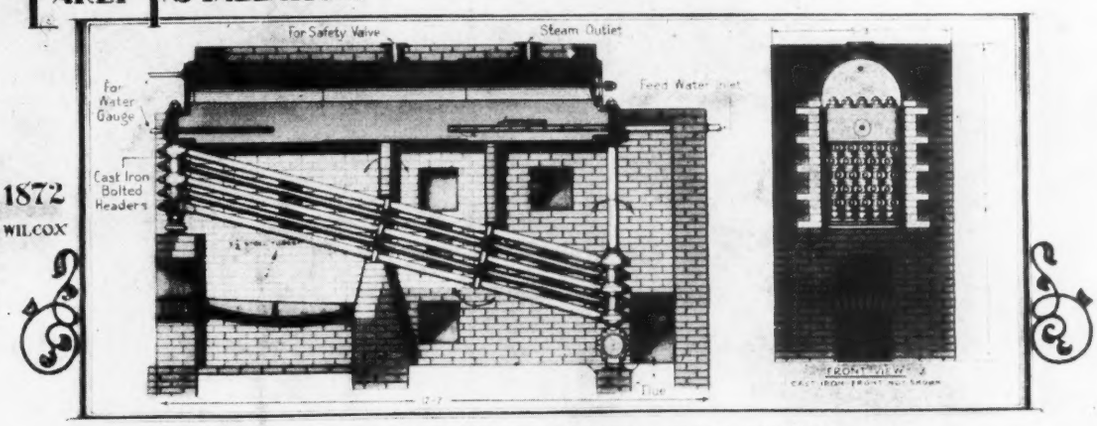
PROGRESS

Water tube boilers did not come into general use at so early a date as the shell boilers due to the difficulties involved in their design and construction which required a high class of engineering and workmanship.

Plain cylindrical shell boilers were comparatively easy to build.

EARLY INSTALLATIONS -

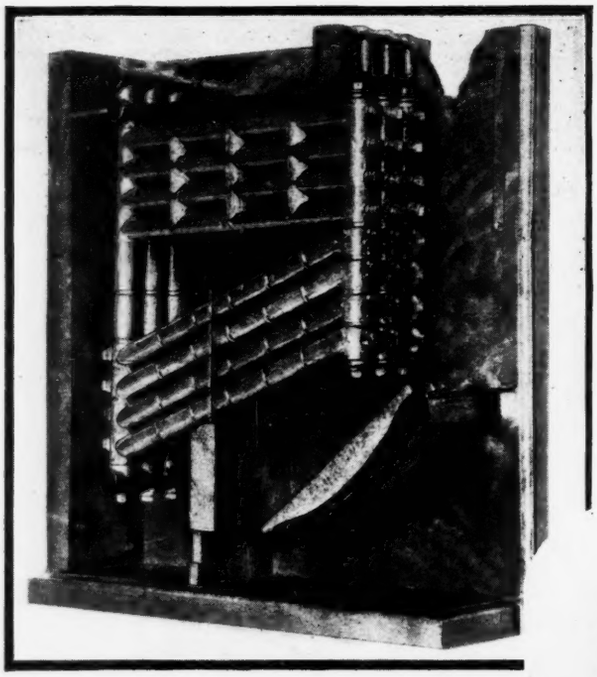
MAY 28, 1872
BABCOCK & WILCOX



A 40 HORSE-POWER BABCOCK - WILCOX BOILER

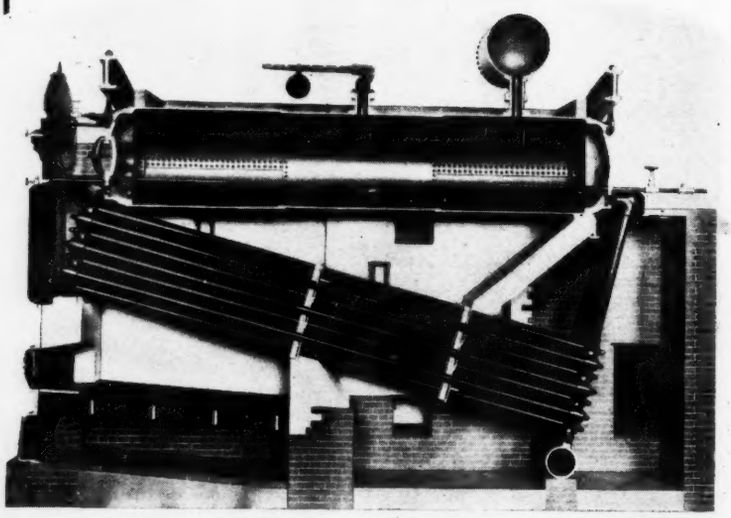
One of a series of cards describing the evolution of the steam boiler

B.&W. Exhibits at Na

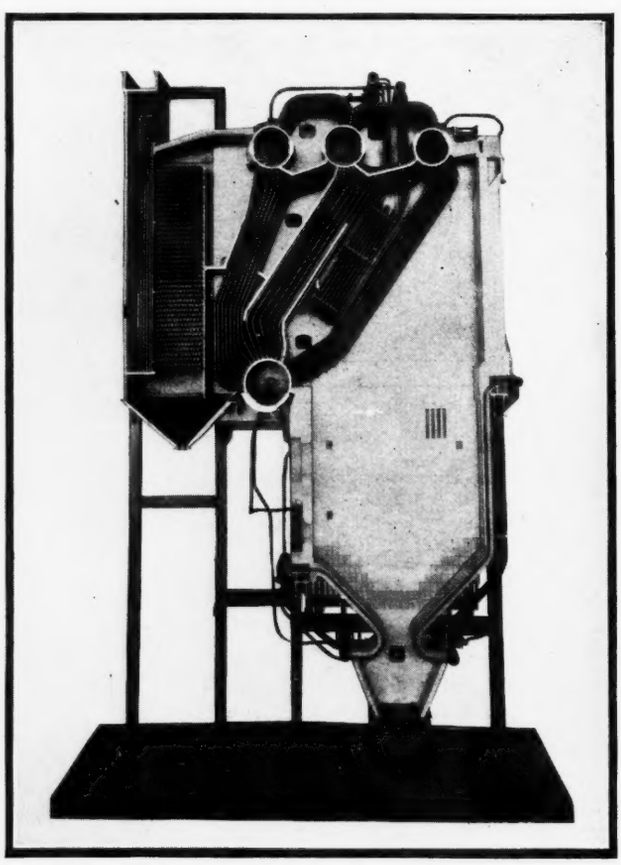


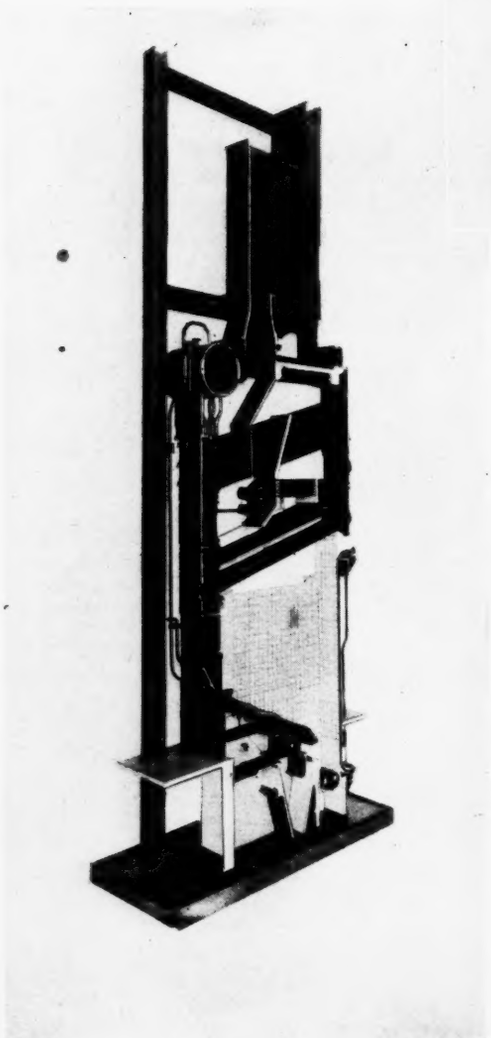
Left — Patent Office model of the B. & W. boiler of 1867

Below — Half-size model of boiler that won the award for sectional steam generators at Philadelphia in 1876



Below—Stirling boiler, 1929, with water walls, economizer, air preheater, and pulverized coal furnace



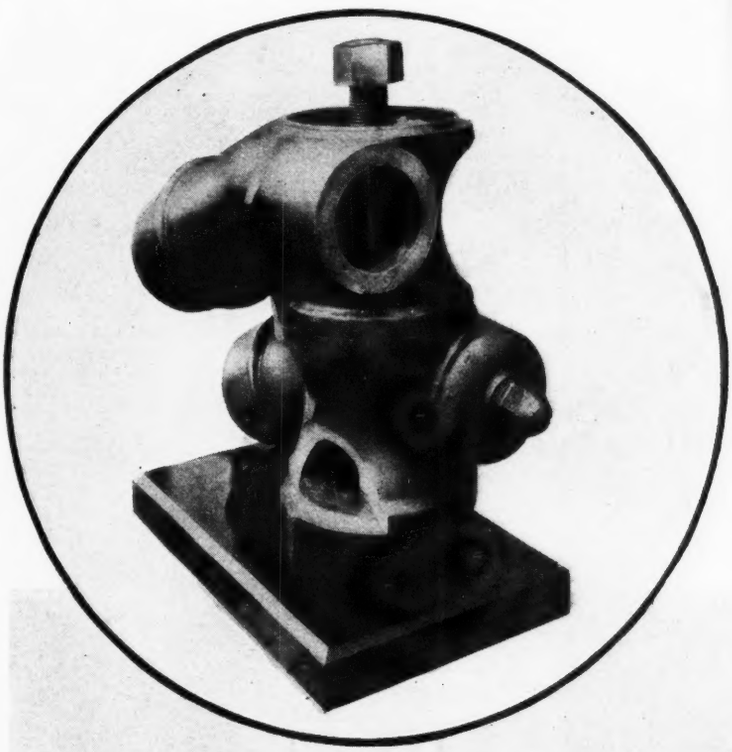


Cross-Drum type boiler, 1929, equipped with Westinghouse underfeed stoker

National Museum

Forged-steel header of 1929 designed for 1,400 lb.; tube end expanded into grooves in header

Header of 1867, built up of cast-iron tube ends, cast integral with the individual tubes



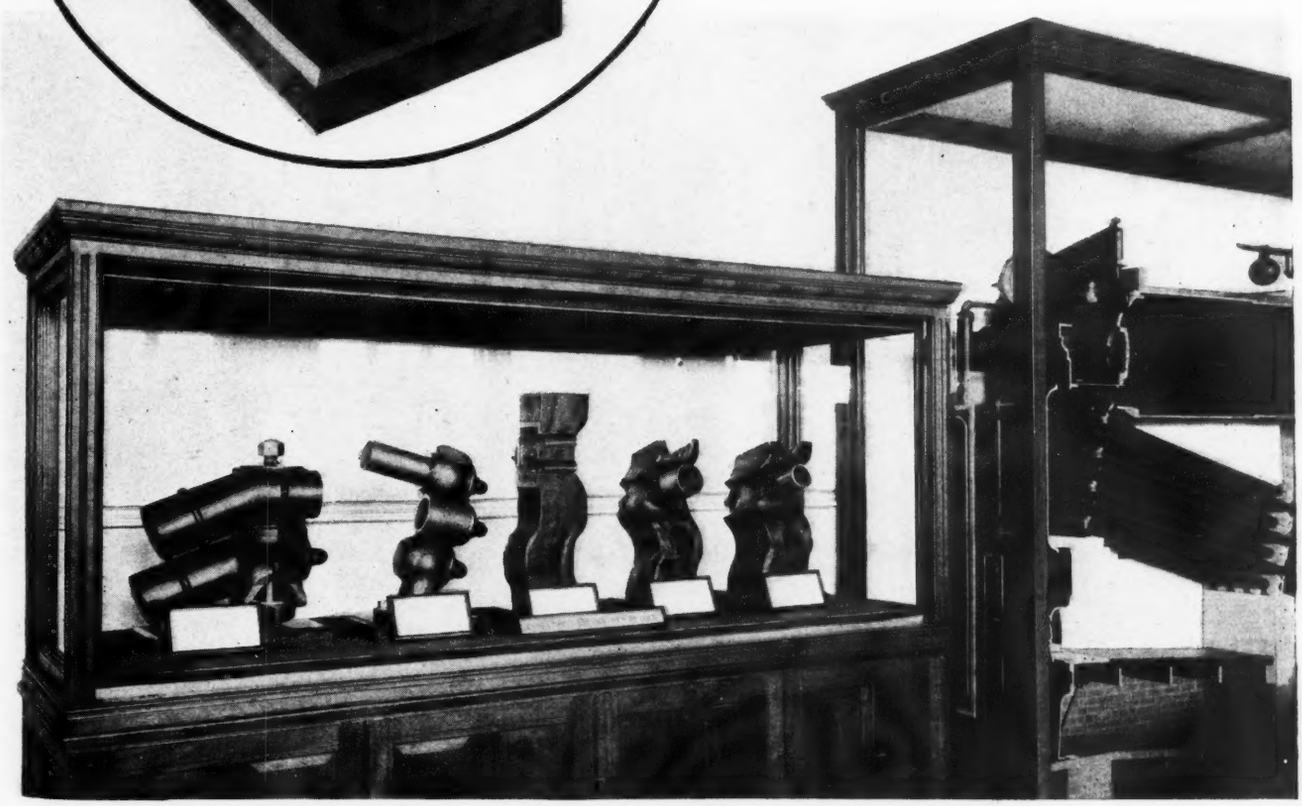
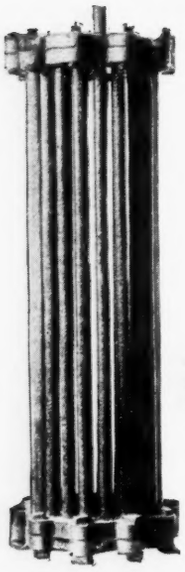
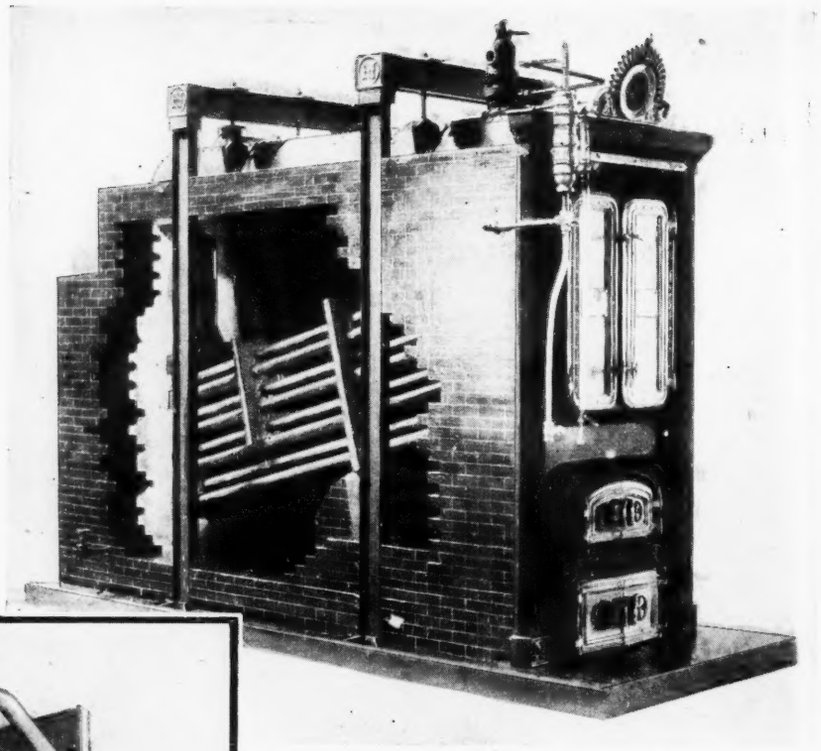


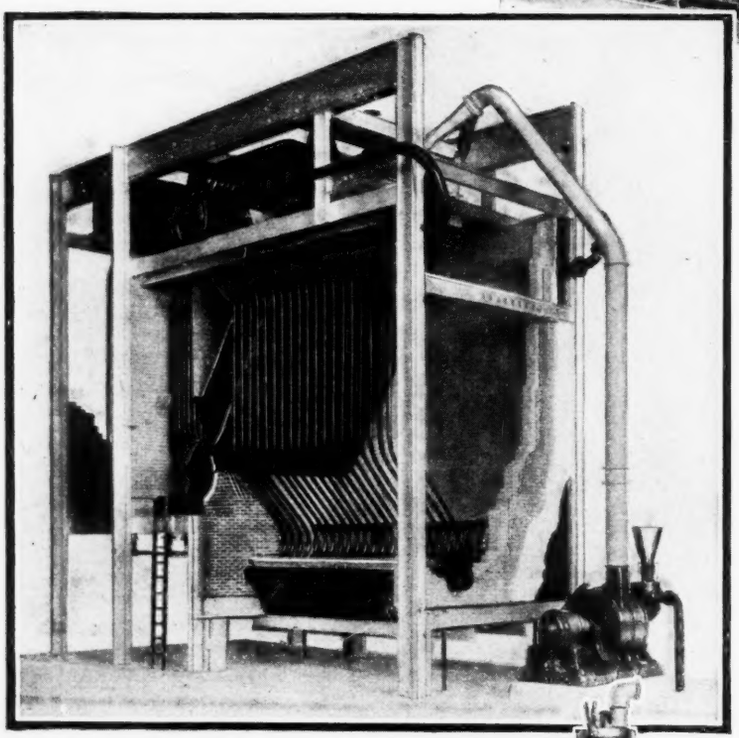
Exhibit showing the evolution of the sinuous boiler headers, 1867 to 1929



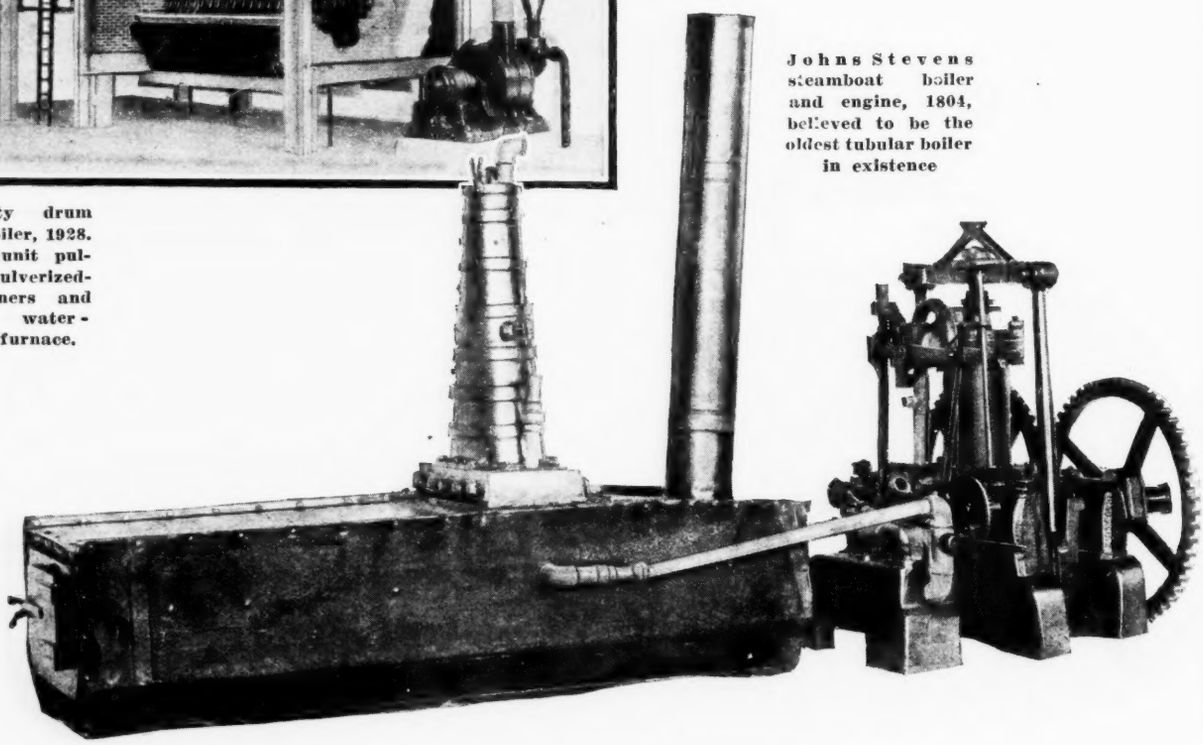
John Stevens locomotive boiler, 1825. Water-tubes and headers



Model of straight-tube National water tube boiler, 1885



Erie City drum type of boiler, 1928. Showing unit pulverizer, pulverized-coal burners and Seymour water-cooled furnace.



Johns Stevens steamboat boiler and engine, 1804, believed to be the oldest tubular boiler in existence

Water Wall Experience at Interborough Station

How defective circulation was rectified in side walls installed under unusual space limitations

By WILLIAM WELCH, JR.
Assistant Mechanical Engineer
Interborough Rapid Transit Company
New York City

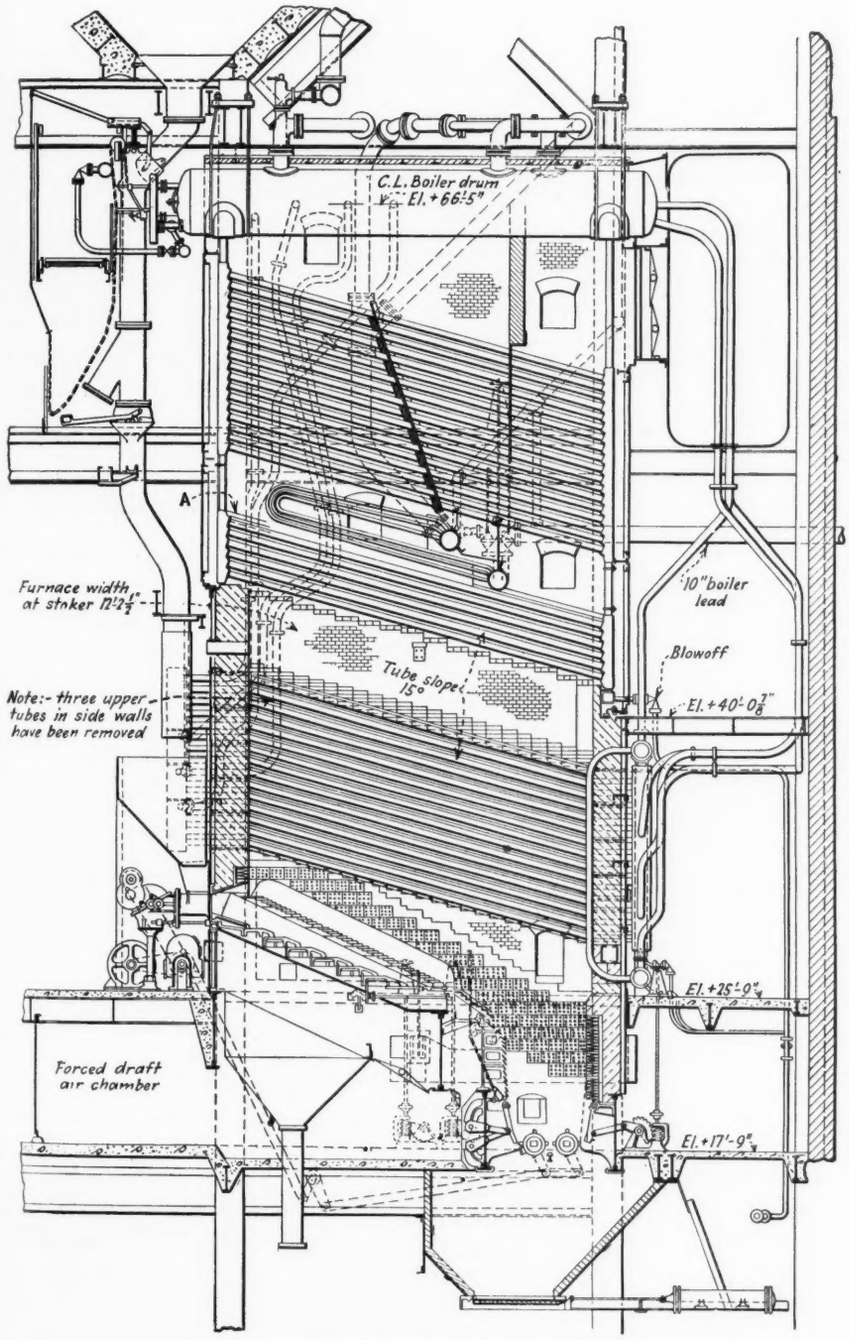


Fig. 1—Section through boiler and furnace

IN 1924 four B. & W. boilers of 11,400-sq.ft. heating surface each were installed at the Fifty-ninth Street power station of the Interborough Rapid Transit Company of New York. There are three drums in each boiler, and the tubes, which are 20 ft. long and 4 in. in diameter, are arranged 21 wide and 24 high. The superheaters are of the single-pass interdeck type, located between the sixth and seventh rows of boiler tubes.

Taylor stokers were installed under the four boilers. These are 7 retorts wide and 37 tuyères long, equipped with double-roll clinker grinders and side-wall air backs. Because of the size of the stoker, the furnace walls were built vertical on all four sides. Ventilated furnace blocks were used in all four walls up to the fire line. Above the fire line the furnace walls are of firebrick lined with asbestos mill board and Sil-O-Cel. The boilers are arranged in batteries of two, with one forced-draft blower and one induced-draft fan for each pair.

The principal data covering these boilers is as follows:

Heating surface, sq.ft.	11,400
Projected grate area, sq.ft.	212
Average height of tubes above grate.	17 Ft. 6 In.
Volume of furnace above grate, cu.ft.	3,710
Cu.ft. of furnace per sq.ft. grate	17.5
Cu.ft. of furnace per sq.ft. heating surface	0.326
Steam pressure, lb. gage	225
Steam temperature, deg. F.	600

Shortly after the boilers had been placed in service a capacity test was made of one of them. During this test an output of 143,000 lb. of steam per hour was maintained for an hour. A series of efficiency tests was run on this same boiler, the results of which were given in a paper before the A.S.M.E. on Feb. 24, 1926, by R. S. Lane.

The performance of this equipment was very good, with the exception of the refractory furnace walls. A low-volatile, low-ash coal of approximately 14,650 B.t.u. per lb. is used at the plant. Excessively high furnace temperatures resulted with this coal on the comparatively large stokers, and the refractory furnace walls suffered serious damage. High rates of combustion, together with the high furnace temperatures, also caused large amounts of molten ash and slag to be deposited on the first row of boiler tubes. This slag accumulation led to large boiler draft losses, with considerable loss in efficiency. Under these conditions the boiler outages for external cleaning and repairs to the brickwork were high.

As a makeshift, the boilers were operated at an increased percentage of excess air, which reduced the CO_2 from 14.5 per cent to as low as 12. Little, if any, improvement was noted in the amount of maintenance necessary under these conditions of operation.

It became apparent that a radical change in the design of the furnace would be necessary. The building of water-cooling surfaces in the furnaces of large boilers was at this time (1926) still in the early stages of development. However, careful study showed that an installation of some type of water wall should greatly reduce, if not eliminate altogether, the faults mentioned. Further study resulted in the selection of the fin-tube water wall.

These water walls, consisting, essentially, of a set of parallel tubes exposed to the radiant heat of the fire, the supply and discharge headers into which the tubes led, and the necessary supply and discharge pipes connecting the headers to a source of water supply, were installed in both side walls and the rear wall. The rear water wall has an effective heating surface of 150 sq.ft., while each side wall was originally designed for 210 sq.ft. It was believed that this amount of water wall surface would reduce the furnace temperature sufficiently to eliminate the necessity of additional protection for the front wall. A cross-section of the boiler, showing the furnace water wall construction, is given in Fig. 1.

Each pair of 11,400-sq.ft. boilers was installed in a space which had been designed when the plant was built to receive two 6,000-sq.ft. boilers. Much ingenuity had been expended to fit the larger boilers into this space. Consequently, there was little room for the installation of water-cooled furnace walls. Furthermore, the boilers were set in batteries of two, with only three inches of ventilating space between adjacent walls.

In the usual design of water wall the tubes are placed vertically, with the supply header horizontal on the outside of the boiler casing at the bottom of the wall and the discharge header horizontal at the top of the wall. While this design could easily be accommodated at the rear wall, it was impossible to apply it to the inner side wall.

A modified design was arrived at for both side walls which placed the supply and discharge headers vertically at the rear and front, respectively, and on the exterior of the casing for protection. The tubes were sloped 15 deg. from the horizontal from the rear to the front header to allow for natural circulation.

Each water wall was made entirely independent of the others and is supplied by a separate system of downtakes from a particular boiler drum, and discharges through a separate system of uptakes to the same drum. The rear wall utilizes the center boiler drum, while each side wall makes use of the drum directly above it. As the drums are completely interconnected through the headers and feed piping, this system prevents the occurrence of any difference in water level between drums. The supply pipes were brought through the drums at the rear heads, and by means of extensions the inlet was brought forward about four feet.

To insure that the wall tubes will always be flooded, the supply is taken from near the bottom of the drums. The discharge lines from the rear wall were brought into the rear head of the middle drum at about the horizontal center line, and the risers from the side wall front headers were brought into the sides of the drums at about the center line. Fig. 2 is an isometric drawing showing the water wall construction. The many bends in the downcomer and riser pipes are due to the necessity of fitting the water walls into an already crowded installation. Fig. 1 illustrates an extreme condition of where the riser and downcomer pipes of the rear wall and the downcomer pipes of the side walls were carried through the boiler flue.

The original design of the side walls provided fifteen 4-in. tubes having two $1\frac{7}{16}$-in. fins. The tubes are parallel at 7-in. centers and slope up from rear to front at an angle of 15 deg. to the horizontal, with the bottom tube just above the fire line. The tubes are bent through the brick walls and are connected to external headers that are vertical and placed at the front and rear of the furnace. The rear, or supply, headers are each connected by two downtake pipes to the boiler drum above the particular side wall. The original design connected each side wall discharge header with the same boiler drum by means of three riser pipes.

For the rear wall screen twenty tubes are used. These are similar to those in the side walls, but are placed vertically. Here the supply header is horizontal and is at the bottom of the wall. The water supply is taken from the center drum through two downtake pipes connected

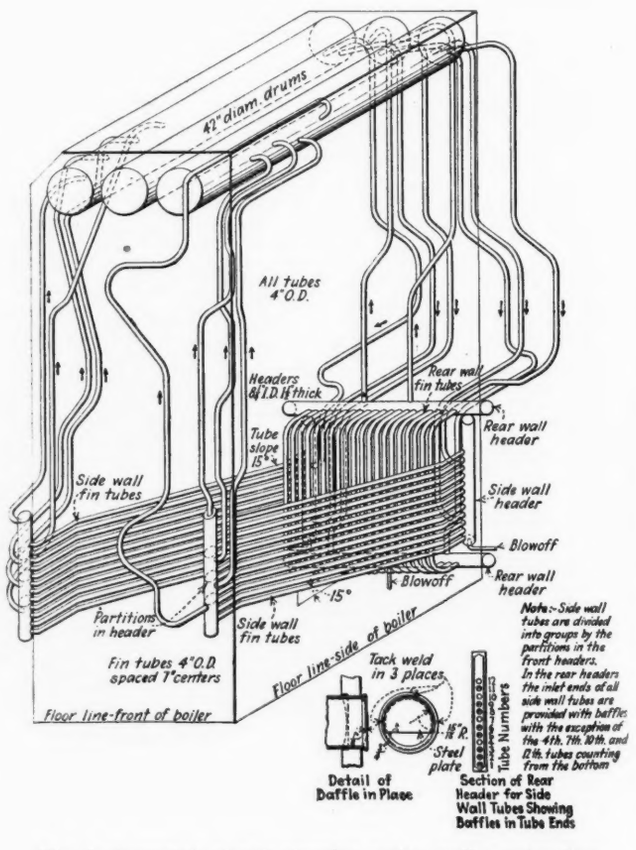

42" diam. drums
All tubes 4" O.D.
Headers 8" I.D. ½" thick
Rear wall fin tubes
Rear wall header
Tube slope 15°
Side wall fin tubes
Side wall header
Blowoff
Blowoff
Rear wall header
15°
Partitions in header
Side wall fin tubes
Fin tubes 4" O.D. spaced 7" centers
Floor line-side of boiler
Floor line-front of boiler
Tack weld in 3 places
8" R.
Steel plate
Tube Numbers
Detail of Daffle in Place
Section of Rear Header for Side Wall Tubes Showing Baffles in Tube Ends
Note:- Side wall tubes are divided into groups by the partitions in the front headers. In the rear headers the inlet ends of all side wall tubes are provided with baffles with the exception of the 4th, 7th, 10th, and 12th tubes counting from the bottom

Fig. 2—Isometric sketch showing water wall construction

so as to give equal distribution in the header. The discharge header, also horizontal, but located at the top of the rear wall, is connected to the same boiler drum by means of two uptake pipes. The downtakes and uptakes for both rear and side walls are all 4 in. outside diameter.

When the boilers with this new furnace wall equipment were put into service it became evident that there was not sufficient circulation of water through the top side wall

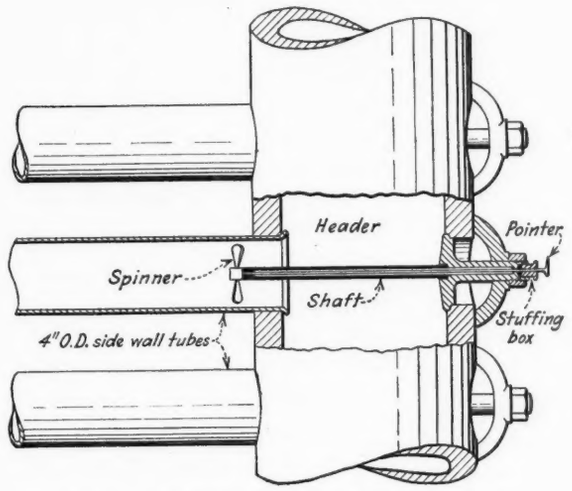


Fig. 3—Flow indicator used to show circulation in tubes

tubes. After failure of several of these tubes a study was made to ascertain the cause. It was found that the risers were not of sufficient capacity to give proper circulation through these wall tubes.

The method[1] for getting an indication of the actual conditions of circulation in the walls is of interest. A number of spinners, each of which consisted of a small wheel, similar to a wind-mill wheel, keyed to a small shaft on the other end of which was a pointer, were placed in handhole caps at various locations in the wall headers. The wheel was placed inside the header, with the shaft passing through a small stuffing box in the handhole cap so that the pointer was outside. The propelling wheel, being located in the fluid stream, revolved according to the direction of flow. This is represented in Fig. 3. The rate of flow governed the speed of the spinner. Consequently, the indicator, on the outside of the header, showed the rate and direction of flow of the fluid within the header at its particular location. Some very interesting conditions were uncovered through the use of this device.

The study showed that there was a bad condition of steam congestion in the upper tubes. At times the flow in these upper tubes was found to be reversed. The first change was to remove the three upper tubes in each side wall, thus reducing the number from fifteen to twelve and the total water wall surface from 570 sq.ft to 485 sq.ft. By this step it was hoped to remove the source of congestion. It was also believed that the risers would then be of sufficient capacity to take care of the reduced side wall. There was a slight dropping off in the number of tube failures.

Since the reduction in the side wall area did not greatly improve matters, the next step was to install one additional riser for each side wall. There were then four risers to remove the steam from twelve side wall tubes. Conditions did not improve much. More extensive tests with the spinners indicated recirculation within the side walls and steam congestion in the two top tubes. Replacements of these tubes were high.

To prevent recirculation within the side wall the front headers were sectionalized by installing three horizontal baffle plates, or diaphragms, in each. A $\frac{3}{4}$-in. hole was drilled in the center of each diaphragm to allow a slight circulation between sections. The diaphragms were placed so that the lowest riser should remove the water from the four bottom tubes, the two middle risers from three tubes each and the top riser from the two top tubes. This device was intended to prevent recirculation in the side wall as a whole. Actually, it set up paths of recirculation in each section. The top tubes and the tube just under the top baffle were especially liable to steam congestion and consequent damage.

The problem then was to direct the water in the proper amount through the top tube of each section. This was done by closing the $\frac{3}{4}$-in. holes in the diaphragms and by restricting the flow in the lower tubes. The inlet ends of all but the top tubes of each section were reduced by plates covering three-quarters of the area of each tube. This is shown as a detail of Fig. 2.

That arrangement is in use at present and apparently provides the proper circulation in the side wall tube. The boilers have now been in regular operation for more than a year since the last changes to the water walls were made, and there have been no tube failures directly attributable to lack of circulation. At no time was there any evidence of insufficient circulation in the rear wall.

The water wall equipment was expected to decrease the steam temperature. This and other points were checked by testing one of the boilers. The results of this test are shown in Fig. 4. A comparison of the curves from this test with those of the acceptance test shows that at 90,000 lb. of steam per hour boiler output the superheat dropped about 50 deg., the draft loss

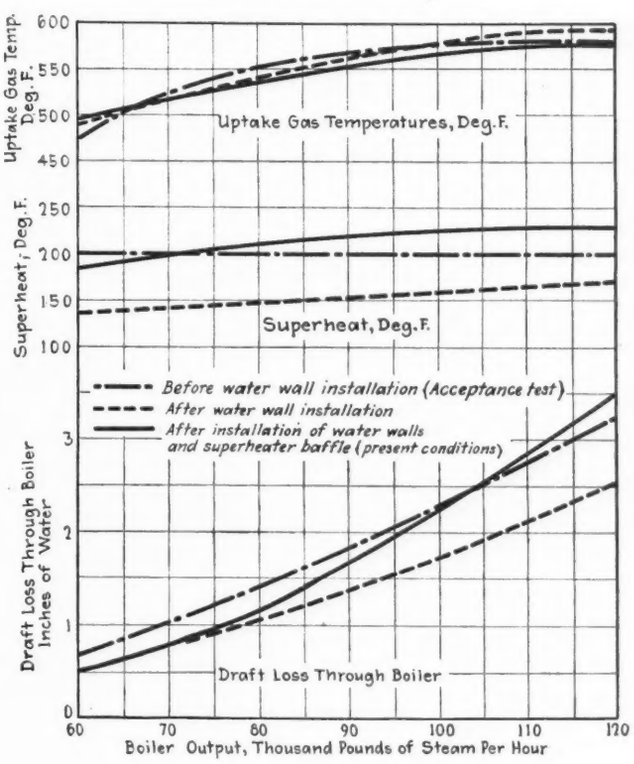


Fig. 4—Test results before and after changes

[1]Developed by engineers of Combustion Engineering Corporation.

decreased by 0.5 in. of water, and there was a slight decrease in flue gas temperature.

To restore the superheat to its original value a short baffle was installed along the top of the sixth row of boiler tubes as shown at *A* in Fig. 1. This baffle was placed just in front of the superheater and extended 25 in. from the boiler front header. Previously, part of the boiler gas had been allowed to bypass the superheater, but with a baffle at this location practically all the gas was forced through it. The superheat was raised to a value slightly above that obtained on these boilers previously to the installation of the water walls.

After the water wall and the superheater baffle work had been completed, tests of one unit were made with the results also as shown on Fig. 3. The equipment of all four boilers is identical and the results given are representative of all. A study of the curves shows that the use of the water-cooled furnace walls has resulted in the following betterments:

1. Between the normal operating range of 70,000 and 110,000 lb. of steam per hour the draft loss through the boiler has been reduced approximately 0.2 inch.
2. The uptake gas temperature at the same range has been decreased approximately 10 deg.
3. At the same range the superheat has been increased about 20 deg.

However, the greatest benefits secured by the application of the water-cooled furnace walls have been the almost complete elimination of refractory failures above the fire line and a large reduction in the slagging of the boiler tubes.

Penstocks Require Periodic Inspection and Maintenance

By Robert Ball
Pittsburg, Calif.

Because of stresses that may suddenly and unexpectedly be encountered, especially under high operating heads, penstock design must include a large factor of safety, and material and workmanship must be of the best. Whether of welded or riveted construction, penstocks must be effectively guarded against excessive pressure rises, or else made sufficiently heavy to resist them. Since disastrous results may follow the incorrect functioning of a relief valve, such equipment must be carefully inspected and maintained, and periodically tested to insure correct operation.

Steel penstocks are often supported above the ground on concrete anchors, and in such cases should be inspected monthly, after any unusual surger and after being filled. An inspector should look for changes in contour or alignment, and leaks of any nature; note range of expansion joint movement, and "breathing" or pulsation of penstock; observe condition of anchors, look for rust, note condition of painted surfaces, check plant growth adjacent to penstock, and note condition of trails, bridges and other parts.

Operation of the head-gate equipment may be required at any time, hence it must be kept in good order. Until proved dependable by experience head gates should be tested daily by being partly closed and opened. Thereafter one or two tests per week are sufficient. More frequent testing merely results in excessive wear without any compensating advantages. When testing, a man must be stationed at the head gate and be in readiness to correct faulty operation.

Air valves are frequently provided to prevent the collapse of a penstock from atmospheric pressure. They should be tested every two months for correct opening and closing. Arrangements should be made to prevent this test's affecting penstock pressure. Means must be provided for carrying away the water from any air valve that does not close properly. Surge or stand pipes must be protected from freezing.

Expansion gland nuts should be kept only tight enough to prevent leakage. New packing will be required at infrequent intervals, depending on the amount of penstock movement and care taken to insure proper and uniform gland pressure.

All penstocks must be well painted or otherwise protected, both inside and out. The condition of the exterior covering can be easily determined during regular inspections, but it is generally difficult to ascertain internal conditions. It is well, then, to carefully inspect the penstock's interior every one or two years if a shutdown can be arranged.

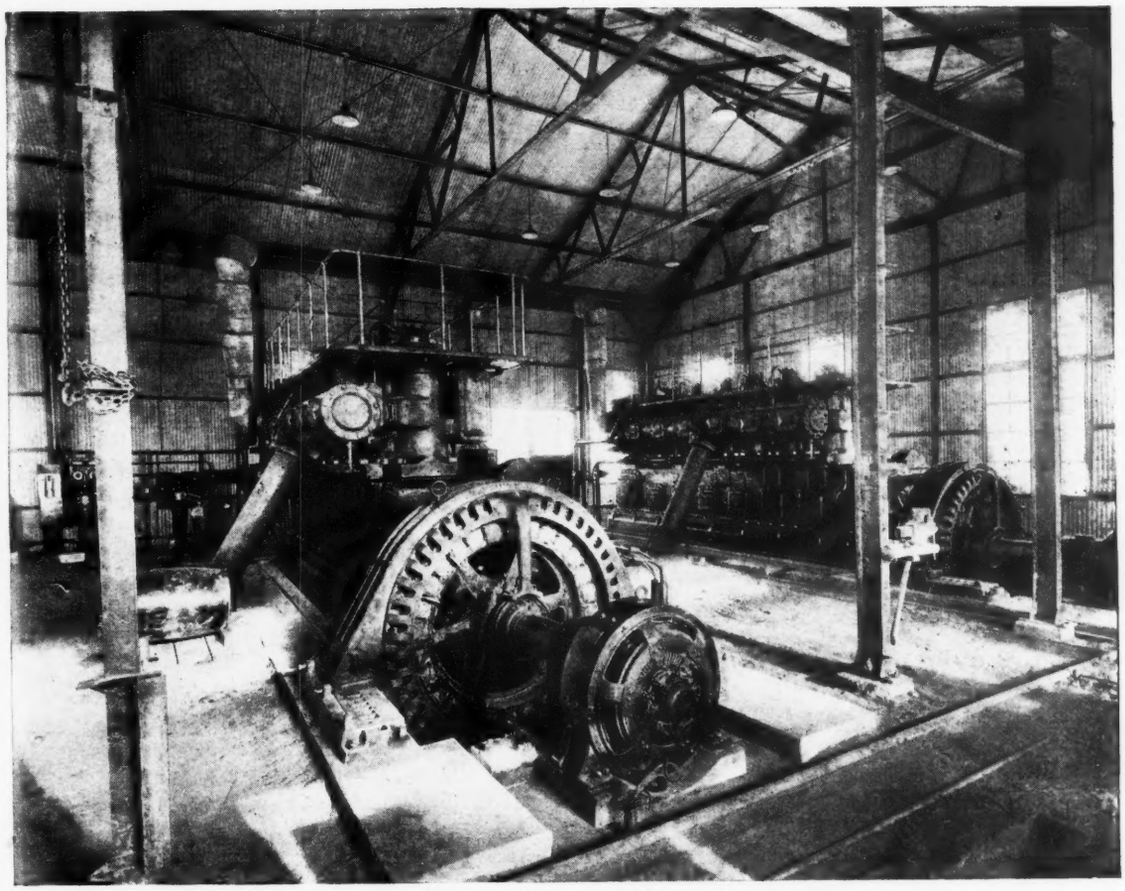
Penstocks should be filled and emptied slowly, conditions permitting, taking at least one hour for a penstock one mile long and 60-in. in diameter. Rapid filling and draining impose stresses that should be avoided. Temperature variations also cause undesirable stresses, hence pentocks should be emptied during the night or at periods likely to have but slight temperature variations. The movement of a penstock that is hot during the day and cold during the night is surprising.

After closing the head gate at zero load a high-head penstock should be drained by operating the unit on hand control at light load, 10 to 15 per cent of full load, thus utilizing the water and avoiding wear and tear on drain valves. Before draining is started a man should be stationed at the penstock air valves to see that they open properly as the penstock pressure falls, indicated on a vacuum-pressure gage. Operation of these valves should again be observed when filling the penstock.

Before men are allowed to enter a penstock the head gate equipment must be blocked and tagged so securely as to make unintentional operation impossible. Any valves provided for connection to other penstocks must also be blocked. Water must not be turned into a penstock until all men are safely on the outside, all tools and rigging removed, and all penstock openings tightly closed. Filling and draining penstocks and reporting men in and clear of them are extremely important operations that should be covered by concise and effective instructions.

Penstock failures are, fortunately, rare; nevertheless they are mishaps to be reckoned with, and the procedure to follow if failure occurs should be made clear in operating instructions.

It is sometimes desirable to motor a generator while the penstock is drained. In the case of impulse turbines this can readily be done. However, cooling water is generally required for the bearings and transformers, and excitation for the generator is required. On reaction-type turbines additional water will generally be required to keep the runner cool. A reaction turbine should not be operated with its casing dry without the approval of the builders, for turbines operated without water have been known to develop serious trouble from heating.



McCarney Texas diesel plant of the West Texas Utility Company

The Diesel as a Prime Mover in Small Power Plants

By K. E. DEAN
District Engineer
West Texas Utility Company

IN THE last few years there has been considerable discussion, as to which, steam or diesel engine, is the more practical prime mover in small- and medium-sized isolated power plants. Much data and information have been brought forward to support both sides. But after due consideration of the authentic information available, the writer believes that the facts are decidedly in favor of the diesel, in any isolated locality, until the combined horsepower of the plant reaches the neighborhood of 3,000 kw., when it is a question of water and fuel supply.

If an abundance of cooling and boiler water is available and the fuel supply is certain and reasonable in cost, the steam turbine will show the cheaper operation in a plant of 3,000 kw. On the other hand, if the water supply is limited or bad the diesel will show the cheaper operation up to around a 5,000-kw. plant, providing the installation does not consist of too many small units. After passing this capacity it often is cheaper to bring in transmission lines, even from considerable distance, and have the energy supplied from a large steam-driven station, located where it has the advantage of ample water and fuel supply.

There are a number of diesel plants in this country operating on the wrong side of the books for the simple reason that they are loaded down with small units. Of course, this was brought about by the fact that a small unit was installed to carry the small initial load and the plant built up around it by the addition of other small units. A careful survey of these plants will often reveal that it would be economical to discard several of the small units and replace them with large ones. Especially does this hold true if any of the units are more than eight years old.

Another contributing cause to poor operation of the isolated diesel plant is the false idea created by some manufacturers that it does not require an engineer to operate and maintain their equipment. The diesel lends itself to intelligent engineering supervision to the same extent as does the high-class steam plant. Instruments

are conspicuous by their absence in the average diesel plant. They can give wonderful returns if properly applied, correctly used and their information correctly interpreted.

It is true that the maintenance of diesel engines will run higher per horsepower than in the case of the large steam turbine. But it is also a fact that a great deal of the high cost of diesel engine maintenance is directly chargeable to poor plant design, poor installation, overload conditions and poor engineering on the part of the operating force. It is also a fact that the maintenance of a plant consisting of a number of small units will run somewhat higher than the maintenance of the same horsepower in larger units.

There are a number of operating conditions which affect maintenance—for instance, air supply: It is generally conceded that it is economy to filter the air supply used for scavenging and combustion. However, if the air filters are allowed to become clogged with dirt and oil, thereby limiting the air supply to the engine, their purpose is defeated and the wear on the engine is likely to be as great or greater than if a filter were not used.

Another admitted economy is centrifugal purification of lubricating oil. It is my experience that the centrifuge is the best agency at the disposal of the diesel operator for removing undesirable impurities from lubricating oil. However, if the centrifuge is not handled intelligently it becomes an expense instead of an economy. It is the practice of most builders of diesel engines today to separate the oil returned from the cylinders from that returned from other parts of the engine. This cylinder oil is accumulated in tanks and given the same treatment through the centrifuge as the used oil from other parts of the engine. From my personal experience I find that it would be more economical to run the oil from the cylinders to the fuel tank and make no effort to reclaim it as lubricating oil. This practice leads to a higher lubricating oil consumption per horsepower-hour, but it reduces general wear on the engine enough to offset the added cost of the oil.

Often one finds a plant with several thousand dollars' worth of air- and lubricating-oil filtering equipment, but with no fuel-filtering equipment. Of course, this plant is not as bad off as it would be if it had no filtering at all, but the designer of the plant has neglected an important item.

It seems to be hard for some operators to understand the damage which results from overloading a diesel engine. Because a large number of them were originally steam engineers, they fail to consider the high temperature at which the diesel operates. They also fail to consider that they are not operating under the same ideal condition under which the manufacturer was operating when he rated the engine.

Engines in central stations pulling electric generators connected to three-phase electric circuits usually operate at a disadvantage due to the unbalanced condition of the circuit throughout a large part of the day. By proper use of the switchboard instruments and correct interpretation of the information they furnish, overloading can be avoided and excessive maintenance avoided.

In practically no part of this country do we find scale-free water available for cooling. It is hard to understand why engineers will build and put into operation plants in locations where the water is known to be bad, without making some provisions for treating that water or providing a supply of soft water for engine cooling. It cannot be a question of cost, because they are only saving a little money on the investment to spend more on maintenance.

One is safe in stating that less than 5 per cent of all the diesel engines in this country are being operated with the proper fuel and compression adjustment. The proper fuel adjustment should be found and maintained. This cannot be done by watching the smoke at the exhaust stack, but should be done by the use of pyrometers and thickness gages, mixed with a sound knowledge of what adjustments to make. In this connection it might be well to state that the thermocouples used with exhaust pyrometers often get dirty, in which condition they will transmit a false reading to the pyrometer voltmeter. The compression adjustment is vital to the starting and operation of the engine. It cannot be checked with a piece of lead between piston and cylinder head, but should be checked with an indicator built for diesel engines.

Generally speaking, the stand-by plant must be maintained in better mechanical condition than the isolated plant. The greatest single problem confronting the stand-by operator is that of starting. Each plant presents a peculiar set of problems of its own, and these must be worked out individually

Fuel is undoubtedly the most expensive item of power plant supplies. Most diesel plant operators feel that they have made the greatest saving when they have purchased the fuel which cost the least per gallon. This is the wrong idea.

The first basis for fuel oil specifications is adaptability to the injection system of the engines; the next is the heat value per pound; then comes ash or noncombustibles, sulphur and water. The objection raised to sulphur in diesel fuel by some engineers is largely based on a myth. Up to 2 per cent, sulphur is no cause to reject a fuel if the oil has other good qualities and if the injection system of the engines is maintained in proper adjustment.

After obtaining the correct lubricating and fuel oil for a diesel plant, too much care cannot be exercised in the storage and handling of oil stocks to maintain them in the condition received.

Another item worthy of careful consideration is spare parts and special supplies that have to come from the manufacturer. It is not good practice to tie up a lot of money in spare parts, yet a sufficient stock should be kept on hand to guard against the usual breakdowns. Properly installed and intelligently cared for, the diesel engine is the most efficient prime mover known for small and medium-sized electric generating plants, but, as was stated in the beginning, they must surrender the field to the steam turbine when the plant grows large, providing sufficient water can be had for the turbines.

In the last few years the diesel has found a large ap-

plication in stand-by service to the great network of transmission lines normally supplied from large central steam plants. These diesel stand-by plants are located at strategic points along the route of the transmission line and kept ready for instant service in case of interruption or failure of service from the transmission line. Several items enter into the operation of these plants that do not occur in the operation of isolated plants.

Maintaining the Stand-By Plant

Generally speaking, the stand-by plant must be maintained in better mechanical condition than the isolated plant. The greatest single problem confronting the stand-by operator is that of starting. Each plant presents a peculiar set of problems of its own, which must be worked out individually.

The starting-air supply is vital to putting the plant into operation, the supply should be checked daily and the man in charge should be sure that his air bottles are charged to the maximum pressure at all times. There has been some discussion as to the amount of air storage provided at stand-by plants. The minimum requirements should be two starts for any engine in the plant. The main compressor should be motor driven, and the air storage should be pumped up in the afternoon of each day if any leakage has taken place. The emergency compressor should be gasoline driven and of about half the capacity of the main compressor. This engine and compressor should be kept in excellent shape at all times. To insure easy starting and smooth operation this unit should be operated a minimum of thirty minutes each week.

The stand-by operator should train himself to check the supply of fuel in his auxiliary and running tanks daily, making sure that emergency supplies are available for instant starting and continued operation until the regular supply can be established. Another point to remember is that diesel engines on stand-by service are likely to lose their priming or air may get into the oil lines leading to the cylinders. The lines should be checked daily to make certain that they are full of oil and contain no air. Failure to do this is probably responsible for a majority of false starts. For winter operation some method of heating the fuel supply should be provided. That will insure proper working of the injection system once the engine is started and running.

Jacket Water Should Be Warm

The demand made on the stand-by plant for instant service dictates that the engine jackets should be kept filled with water at all times, thus preventing a delay of ten to fifteen minutes in getting a plant into operation. Good practice requires that stand-by plants be equipped with some method of heating whereby the water in the engine jackets can be kept heated to about 100 deg. F. throughout the cold months of the year. This will eliminate many false starts and will allow the engine to pick up its maximum load immediately after being started.

Lubricating oil should be watched closely in the stand-by plant. Storage tanks, pipes and closed containers are given to sweating during rest or shutdown periods. To eliminate the water thus accumulated the lubricating oil should be passed through the centrifuge at least once a month, regardless of whether the plant is operated or not. Lubricating oil should also be kept warm in freezing weather.

The piston ring is the packing, or sealing, agency between the cylinder wall and piston. The efficiency of this ring depends upon an oil seal around the ring and between the ring and the cylinder wall. The only way this seal can be established and maintained is by operation of the engine. When the engine is shut down after several hours' operation this seal is assumed to be perfect. But when the engine is idle the seal is gradually lost and the engine becomes hard to start, and there is danger of scoring the piston or cylinder wall if it does start. To guard against loss of seal the stand-by engine should be started and operated for an hour once each week. In case the engine has been allowed to stand for several weeks without starting, a small amount of warm lubricating oil should be poured into the cylinders and allowed to run down around the pistons and rings before a start is made.

The practice of starting stand-by engines and operating for fifteen or twenty minutes is bad. The engine should be operated at least one hour under full load, and if it is a large engine it should be operated longer than that. There are a number of reasons why this practice should be adhered to.

In operation, a diesel becomes heated in all its parts, starting at the cylinder head and spreading over the engine. If the engine is operated for a short time only this heat is unevenly distributed and when shut down the engine will cool unevenly, which might result in distortion of some of the parts and lead to leaking at the cylinder head joint. Another reason for operating an engine for a reasonable length of time is to clear the combustion space, exhaust nipples and pipes of the foul gases, excess fuel and lubricating oil that accumulated while the engine was at rest and was being started after an idle period.

Exhaust and intake valves; injection needles, or valves; fuel pumps; bypass, or metering, valves; governors; rocker arms; and cams of a stand-by engine require as much or more attention as they do on a running engine.

Scheduled Inspection Essential

With proper auxiliary equipment and properly maintained, there is no prime mover in existence that approaches the diesel for stand-by service. But the engineer in a stand-by plant is likely to get lazy and allow the equipment to get into bad condition. The best way to overcome this fault is to establish a schedule of inspection and operation that will maintain the plant in first-class condition. And it should be carried out as religiously as the operating schedule would be carried out were the plant in continuous operation. Such a procedure will insure service from the stand-by plant.

✦

Plastic State of Coal During Coking—This is the subject of a paper by Joseph D. Davis and D. A. Wallace, presented at the Cincinnati Meeting of the American Chemical Society in which the authors state that:

1. Coals which remain plastic over the widest temperature range swell the most.

2. Fluidity, for coals of less than 35 per cent volatile matter, parallels hydrogen content. The most fluid coals are high in volatile matter.

3. High fusion and setting temperatures accompany high fixed-carbon and low oxygen content; for such coals the shrinkage temperature is also high.

Stokers and Pulverized-Coal Burners Used in Nearly Every Public Utility Plant

HAND FIRING is still practiced at some small plants built years ago, but the total quantity of coal burned under hand-fired boilers was only 973,000 tons, or 2.3 per cent, in 1928, according to a study of the sources of coal and types of combustion equipment used by public-utility power plants in 1928 just completed by the Geological Survey of the Department of the Interior in co-operation with the Institute of Economics of the Brookings Institution. Fully 97.7 per cent of the coal burned in that year was fired mechanically, either on stokers or in pulverized form. Of special interest is the quantity burned in pulverized-coal burners, which was found to be 7,112,000 tons, or 17 per cent of the total.

Fields Supplying the Electric Utilities

Virtually every producing district supplied coal to the public utilities in 1928, but certain districts furnished the bulk of the supply. The low- and medium-volatile bituminous fields of the East (central Pennsylvania, Somerset-Mayersdale, Cumberland-Piedmont and Pocahontas-New River) contributed 12,827,336 tons. The high-volatile fields of the Appalachian region, extending from Ohio and Pennsylvania south to Virginia and Tennessee, furnished 12,678,002 tons. The Eastern Interior fields—Illinois, Indiana, and Western Kentucky—contributed 9,972,000 tons. Of the individual districts shown, Illinois led all others, with 5,904,000 tons, followed by central-Pennsylvania, Pittsburgh-Westmoreland, New River, Pocahontas, the Pennsylvania anthracite region, and Indiana, in the order named. Each of these districts supplied over 2 million tons for utility consumption, and six others furnished between 1 and 2 million tons.

Coal Used for Pulverizing

A wide variety of coals was used in pulverized form, ranging all the way from anthracite dredged from the Susquehanna River to Texas lignite. The largest quantity, 1,258,439 tons, came from the Pittsburgh-Westmoreland district, but nearly all districts were represented, including both high- and low-volatile coals of both the East and the West. In the Far West considerable tonnages of sub-bituminous coal were pulverized by the utilities. All the 464,553 tons of Texas coal used in pulverized form was lignite.

Coal Used on Other Types of Equipment

Although the use of pulverized-coal burners seemed to bear no systematic relation to the character of the coal, the distribution of underfeed and chain-grate stokers was closely correlated with such factors as ash content of the coal, fusing temperature of ash, and tendency to coke. With the strongly coking low-volatile coals of the eastern Appalachian region, the chain-grate stoker was seldom used, and the underfeed stoker was overwhelmingly dominant. The underfeed type also predominated with the high-volatile coals of the Appalachian region. With the Middle West coals, on the other hand, the chain-grate stoker outranked the underfeed type. Chain-grates of special type predominated also with Pennsylvania anthracite and with the lignite of North Dakota. It must be emphasized, however, that, to greater or less degree, both underfeed and chain-grate types were used with the coals of practically every district.

Relation to Supplies of Condensing Water

Among the factors influencing the location of power plants is an adequate supply of condensing water. It was found that 60.3 per cent of the total tonnage of coal was consumed by plants located either on tidewater, on the Great Lakes, or on certain of the largest rivers. The greatest concentration lay at the Atlantic seaboard from Chesapeake Bay north to Boston.

Equipment Installed in Each State

Continuing the analysis by showing the tonnage burned in each consuming state, classified by type of combustion equipment, the study reveals that the largest consumption in pulverized-coal burners was reported in Ohio, Pennsylvania, Illinois (including East St. Louis), Michigan, Wisconsin, New York and Texas. In Georgia, Louisiana, Rhode Island, Texas and Wisconsin more coal was consumed in pulverized burners than in any other type of equipment. Among the several types of mechanical stokers, the choice is largely influenced by

SUMMARY OF COAL CONSUMED BY UTILITY POWER PLANTS IN 1928, GROUPED BY TYPE OF COMBUSTION EQUIPMENT

	Net Tons Consumed	Per Cent of Total
Burned as pulverized coal	7,112,739	17.0
Burned on underfeed stokers	20,567,496	49.0
Burned on overfeed stokers	1,242,040	3.0
Burned on chain-grate stokers	12,057,883	28.7
Burned under hand-fired boilers	973,068	2.3
Total	41,953,226	100.0

the character of the coals available. Generally speaking, the underfeed stokers predominated in the eastern part of the country, in the Northwest, where lake cargo coals from the Appalachian region are consumed, and in Arkansas, Oklahoma, Kansas, Colorado and Utah; the chain-grate stoker, on the other hand, predominated in the Middle West, in North Dakota, Wyoming and Washington and in northeastern Pennsylvania, where the steam sizes of anthracite are largely used. It should be remembered, however, that though one stoker may predominate in a state, very frequently two or more other types of stokers are much used in the same state.

The figures have an immediate interest to producers, wholesalers, and consumers of coal. Although directly they relate only to the coal used by electric-utility power plants, indirectly they throw light on the entire market for steam coal. In a given locality steam coals from a dozen different fields may be available, and the choice between them depends on prices f.o.b. mines, on length of haul and transportation costs, on the heating value and burning qualities of the coal, on the type of equipment in which it must be used, on the reliability of supply and on other factors. By showing what coals were actually selected for use in each state, the detailed study indicates the preferred sources of steam coal under the market conditions of 1928.

. . . RIGHT OUT OF THE PLANT . . .

Hydraulic Lift for Placing Ice Cakes on End

SEVERAL months ago I designed and installed a hydraulic system in an ice plant for up ending 24 cakes of ice at one time, and it occurred to me that the details of the system might be of interest to other readers of *Power*.

In this plant the ice is pulled from the freezing tanks 24 blocks at a time, dumped on a traveling carrier and conveyed to the ice house. These 300-lb. cakes are approximately 11 in. thick, 22 in. wide and 40 in. or more long, and they reach the ice house lying on edge. After this they are handled standing on end. The work of up ending the ice formerly had to be done one block at a time by a man with ice tongs.

There were a number of available machines for doing this work, but the cost was too great and their capacity too small. It was therefore decided to build a suitable machine. Accordingly, a section of the ice house floor was transformed into a long platform, or table, and hinged along one side by trunnion bearings to permit it to be raised up side ways. Under this table were placed four hydraulic cylinders of 6-in. bore and 22-in. stroke. These were hinged at one end, and the piston rods were hinged by bearings to a line along the under side of the table. An oil storage tank was located in a pit, and a small motor-driven pump was installed to pump the oil to the cylinders.

Referring to Fig. 1, the oil pump discharge is connected to the valve control unit at *A*. It will be seen that before oil pressure can be built up in the first chamber of the valve, or on the cylinder, the plunger *E* must be pushed far enough over to close ports *B* in the shell end of the plunger. As the pressure builds up in the valve and on the operating cylinders, the table is pushed

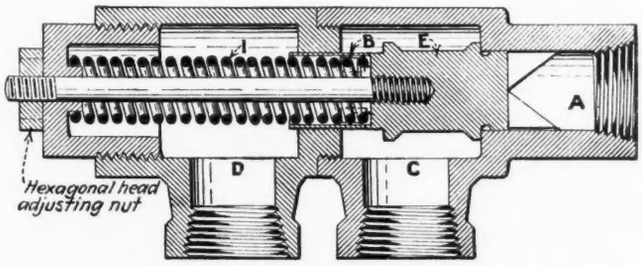


Fig. 1—Double-seated plunger-type valves used to control oil flow to and from hydraulic operating cylinders

up sufficiently to stand the ice on end, the table stopping with full pressure on the cylinders. To take care of the normal increase in pressure when the table stops, the safety valve shown in Fig. 2 is connected with the feed line to the cylinders. When this valve, which is set at about 15 lb. above the normal operating pressure, opens it operates the circuit breaker mounted on top of the stem. This breaker, in turn, opens the magnetic switch on the oil pump circuit. When oil stops flowing to the valve shown in Fig. 1 the spring *J*, which is set at about half the tension of that in safety valve (Fig. 2), imme-

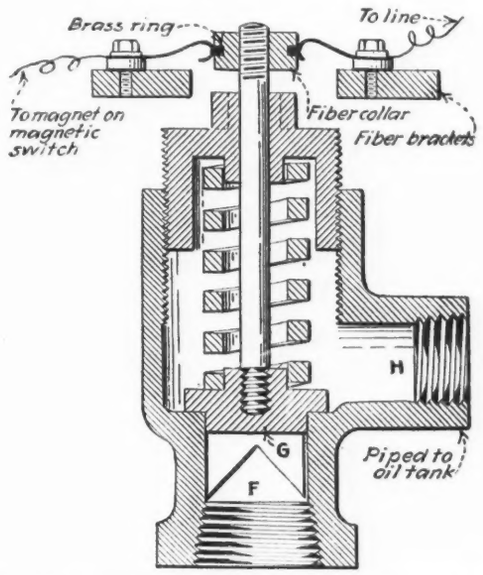


Fig. 2—Pressure-relief valve with auxiliary circuit breaker mounted on stem

diately throws the double-seated plunger *E* in the opposite direction and thus opens ports *B*. The weight of the table then forces the oil from the cylinders back to the storage tank through connection *D*, permitting it to return slowly to the loading position. When the table is again loaded all that is necessary is to push a button to start the motor, and the table again performs its work and returns automatically. This arrangement saves the cost of one man, which represents a saving of at least $1,800.

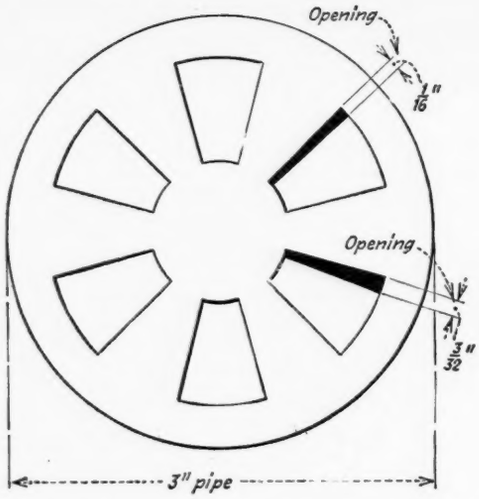
G. C. ALLEN.

Los Angeles, Calif.

Why the Pump Ran Slow

A RECENT experience in starting a pump may be interesting to *Power* readers.

The pump, which is a single-cylinder unit with a 15-in. steam cylinder, an 18-in. water plunger and 18-in. stroke, is used as an air pump on the suction line of a water-



Sketch of plate removed from exhaust connection

works plant. It had been in operation at another plant and had never given trouble, but it operated condensing instead of exhausting to atmosphere.

After starting up the best we could get was about 10 strokes per minute, which was much too slow. We removed the piston and looked over the rings. These were found O.K., but we discovered an obstruction in the exhaust connection to the steam cylinder. Disconnecting the exhaust pipe, we removed the exhaust flange and found a valve-like contrivance screwed into the flange. The bushing into which the exhaust line fitted was similar to a 2½x3-in. bushing, but in the bottom it was made solid, except for a series of ports which corresponded with a series of ports in another flat plate that was screwed in ahead of the bushing. As shown in the illustration, these ports were set so that only a small opening was allowed in two of them. It was impossible to turn the bushing or the plate either way to get any more opening, so we cut out the whole bottom of the bushing. After starting the pump it ran O.K. We are still wondering why the "choker" was put in the exhaust.

JOSEPH O'BRIEN.

Rosedale, N. Y.

Tiller Rope Should Not Be Used on Elevator Governors

I HAVE just noticed the article "Elevator-Rope Mileage Records Show Wide Variation," in *Power*. In Tables III and IV reference is made to the use of tiller rope for governors on both the car and the counterweight. In the last paragraph of the article further reference is made to tiller rope for this purpose.

It is possible that on the elevators in question the governor clutches might be so designed that tiller rope is satisfactory. But as a general proposition tiller rope should not be used on governors. The wires are too small and the construction is such that the rope is too soft to be gripped in a governor clutch. In the A.S.A. elevator safety code the use of tiller rope for governors is prohibited. In the April, 1925, edition of the A.S.A. year book reference is made to this matter in rules 215-I and 314-I on pages 48 and 73, respectively.

C. R. CALLAWAY, *Vice-President*,

New York City. Gurney Elevator Co,. Inc.

Determining Proper Size of Natural Draft Chimneys

THE EDITORIAL on "Chimney Data" in the July 22 number raises several questions regarding the design and performance of natural-draft chimneys, and also suggests that tests be made on operating chimneys to determine where improvements can be had. It is my opinion that there is great need not so much for more available data on operating chimneys as there is for a method of determining the proper size that is more logical, correct and comprehensive than "picking" a size from a table based on boiler horsepowers. The performance of a natural-draft chimney is similar in all respects to that of a centrifugal pump, or a fan, and the characteristic curves of all three are, in general, quite similar. With this similarity in mind, it is quite obvious that it is no more possible to determine the proper size of a natural-draft chimney based only on boiler-horsepowers than it is to determine the proper selection of a centrifugal pump, or a fan, from data, or tables, based only on the capacity requirements. Just as it is necessary to know, in addition, the head required for a pump, or a fan selection, so it is equally necessary to know the head, or draft, required for a chimney selection. It is a safe guess that the great majority of the operating troubles of the existing steam plants can be traced to the size of chimney, which may be too high or too short, too large or too small in diameter, or badly proportioned.

In investigating the performance of an operating chimney of the natural-draft type, and also in designing a new chimney of this type, it is necessary to dissociate the chimney from the rest of the plant and treat it as a free body. A chimney is just as foreign to, and as intimately connected with, the rest of the plant as a fan, for example.

In general, both the performance and the selection of the required size of a natural-draft chimney is based on the following operating factors:

1. Required draft, consisting of:
   - (*a*) Draft loss through the grates and fuel bed.
   - (*b*) Draft loss through the boiler.
   - (*c*) Draft loss through the accessories.
   - (*d*) Draft loss through the breeching.
   - (*e*) Draft loss due to velocity.
2. Quantity of gases generated in the boiler and passed on to the chimney. This quantity should be expressed in some convenient term, such as pounds per second. These gases are then accommodated by the chimney at a certain velocity in feet per second.
3. Atmospheric temperature.
4. Atmospheric pressure corresponding to altitude of plant.
5. Density of chimney gases.
6. Chimney gas temperature.
7. Coefficient of friction.
8. Chimney gas velocity.

Factors 1 and 2 are, of course, extraneous to the chimney but represent the head and capacity conditions, respectively, imposed upon the chimney and correspond to the head and capacity conditions imposed upon a centrifugal pump or a fan. Factor 3 depends upon weather conditions, is quite variable, but is beyond human control. Factor 4 depends upon the elevation of the plant above sea level, but is constant for any locality. Factor 5 depends upon several varying factors, but withal is fairly constant and a maximum variation has

but little effect on the intensity of the draft or the chimney size.

Factor 6, the chimney gas temperature, corresponds to the temperature of the gas leaving the boiler, the intensity of which is dependent upon several factors. Since the performance of a chimney varies directly, and the required size inversely, as the chimney gas temperature, it is to the advantage of both that the temperature be as high as possible. Good utilization of heat in a steam-producing plant, however, demands that it be used to produce more steam rather than more draft, and in this case the chimney gas temperature should be as low as possible. The maximum mechanical efficiency of a natural-draft chimney is attained, under average and mean operating conditions, at a gas temperature of around 600 deg. F., and little is gained by operating a chimney at a higher temperature. Most chimneys, however, are operated at a gas temperature of 500 to 550 deg. Between the temperatures of 500 and 600 deg. both the theoretical and available draft will vary, roughly, 1 per cent per 10 deg. variation in temperature. Below 500 deg. the variation is greater and becomes increasingly so as the temperature decreases.

Your editorial suggests that data should be made available on the drop in temperature from bottom to top of stacks of varying construction, and of infiltration through the walls. Regarding the temperature drop due to radiation, little information is available, and it is questionable if more information would be of any value. The average economical velocity of the gas in properly designed chimneys is around 30 ft. per second. In the case of a 100-ft. chimney, a strata of gas will be in the chimney only slightly more than 3 sec., and only about 6½ sec. in a 200-ft. chimney. It is difficult to imagine an appreciable temperature drop in these short periods of time, particularly so when it is realized that the inside surface of chimneys, regardless of the type of construction, is not cool but relatively hot. Some heat, of course, is lost by radiation through the steel shell of unlined steel chimneys, but the radiation through the walls of brick and concrete chimneys, as well as through the lining of steel chimneys, is practically negligible, on account of both the thickness of the walls and also the character of the materials.

Even if a wealth of information regarding temperature drop were at hand and the drop was found to be of some consequence, it would avail nothing for existing operating chimneys. Likewise, this same information would prove of little consequence in designing new chimneys, since the anticipated chimney gas temperature can only be estimated, and the variation between the actual and anticipated figure would be at least as great as any possible future temperature drop. A variation in the atmospheric temperature is of infinitely more consequence on both the performance and design of natural-draft chimneys.

Infiltration of air through cracks, vents and improperly constructed joints and through connections between breechings and chimneys is obviously of great consequence, and the temperature drop due to this cause may be, and usually is, considerable. The remedy for this condition, of course, is to keep the chimney in a state of good repair and the joints well sealed. Too little attention is ordinarily paid to the repair of chimneys.

Tests on operating chimneys to determine more accurately the coefficient of friction would be of great value provided they were made after the chimney had been in operation for a considerable length of time. The coefficient of friction should be the same regardless of the material of which the chimney was built, since, in time, all surfaces are covered with a layer of soot.

It would be difficult to determine the effect of winds on chimneys from tests, and any conclusions arrived at would be only relative. Present practice in designing to resist wind pressure appears to be safe, as is attested by the fact that the known failures due to tornadoes in the last 25 years can be counted on the fingers. No other class of structures of any consequence can present a record which would even approach this.

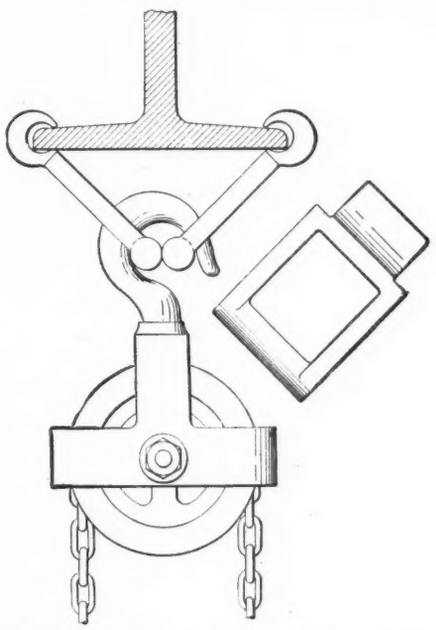
With the foregoing facts in mind, it is indeed questionable if the expense incidental to such tests suggested in your editorial would be warranted. Neglecting the expense item, there is still a question as to whether the results of such tests would be of any value.

Rather should we revise the custom of "picking" chimney sizes and go at a chimney problem in the same common-sense manner that is used in attacking a centrifugal pump or a fan problem. J. G. MINGLE.

Indianapolis, Ind.

Convenient Means for Anchoring Chain Hoist to I-Beam

WITH reference to the article by W. S. Whiting, Jr., in the July 29 number relative to Convenient Means for Anchoring Chain Hoist to I-Beam, I see a dangerous condition existing by reason of the position of the links in the hook. As will be apparent,



Hoist suspended from beam by chain links

any weight placed upon the links will tend to spread the hook, with obvious results. Cables, etc., used in connection with lifting hooks should be so arranged within the hook that there can be no spreading action.

In the sketch shown (reproduced herewith) it would require a comparatively small amount of strain to damage the hook. The spreading action in this case could be eliminated by using a short length of cable or chain between the links and the hook.

between the links and the hook. JOHN F. HURST.

Louisville, Ky.

From Among Readers' Problems

Conducted by
L. H. MORRISON

USE OF COPPER FOR STEAM PIPING—*In modern land practice why is copper considered unsuitable as a material for steam piping?* M. C.

Copper deteriorates rapidly under high temperatures and repeated stresses. At a temperature of 360 deg. F. its strength is about 15 per cent less than at ordinary atmospheric temperatures, and on this account, combined with the fact that the coefficient of expansion from heat is about 50 per cent more than that of iron or steel, copper pipe is unsuitable for the high pressures used in modern practice.

Although formerly used for condenser and other low-pressure connections, on account of the adaptability of the material to construction of intricate forms, for present-day land practice these are made up of iron and steel, usually obtainable at less cost, with equal durability and greater safety.

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OPERATING ALTERNATING-CURRENT GENERATORS AS SYNCHRONOUS CONDENSERS—*Can alternating-current generators connected to their prime movers be operated as synchronous condensers to correct the power factor of a system? If they can, how are the machines started and what precautions must be taken to obtain satisfactory operation.* M. C. W.

Either steam-turbine-driven or water-wheel-driven generators are being used for this purpose. If the machine is connected to its prime mover it is started in the usual way and synchronized. After the generator is connected to the bus-bars, the throttle valve or the gates, as the case may be, are closed and the machine will operate as a synchronous motor to drive the prime mover.

If the generator is disconnected from its prime mover, starting may be accomplished by connecting the generator in parallel with another standing machine through a dead section of bus. Then excite the field coils of both generators and start the machine that is connected to its prime mover. As this machine comes up to speed the other will come up with it. The machines are synchronized with the station and the bus switch closed, after which the unit used to do the starting may be shut down.

When operating generators as synchronous condensers connected to their prime movers there are number of precautions that must be observed. Where the prime mover is a steam turbine, about 10 per cent full-load steam should be allowed to pass through the turbine to keep the blading cool, and the vacuum should be maintained at a normal value. If this is not done on high-speed machines the friction of the air in the casing on the blades will cause the machine to overheat and distort the wheels. Some of the older type of machines operating at a comparatively slow peripheral speed may not require cooling with steam.

On waterwheels provisions must be made to supply sufficient water to the runner seals to keep them cool. In some cases the leakage through the gates is more than sufficient to do this. When the water is closed off entirely the seals must be connected to the penstock. Provisions must also be made to break the vacuum in the draft tube to prevent the water from holding up in the runner. If this is not done the power to run the unit as a synchronous condenser may be 8 to 10 times what it should be, because of the runner's acting as a pump.

—❖—

BABBITTING BOXES OF SMALL ENGINE—*We have found difficulty in babbitting the upper sides of one of the boxes of a small engine. How can the metal be made to fill the cavity?* R. J. A.

Surface and interior cavities sometimes are caused by having runners and risers too small for the metal to remain liquid and feed the casting until it has set throughout. It may be that the box and mandrel were not sufficiently heated to prevent the metal from becoming so chilled that it could not meet from opposite sides of the mandrel. The "sprue," or runner, should be built up with clay several inches above the top of the box, so the molten metal may be supplied under greater head, and there should be a vent or riser to prevent pocketing of air in the upper part of the cavities that are to be filled with babbitt.

Best results will be obtained by thoroughly cleaning and tinning the box before babbitting and by continuing the pouring until the flow of metal from the vents is stopped off and the riser is kept filled.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WHAT is the best way to restore the insulation of armature windings and field coils that have become oil soaked? Can gasoline be used satisfactorily for cleaning, and what is the best way of applying the cleaning fluid? S.W.A.

IF FEASIBLE, completely dismantle the machine to facilitate cleaning. Metal parts may be cleaned with kerosene, benzol or gasoline, using a wire brush or steel wool. Remove as much dirt and oil as possible from the insulation, using wood or fiber tools for scraping and straw or fiber brushes.

Next, support the field coils over a shallow tank or pan, thoroughly wash with gasoline, then wipe them dry. The armature should likewise be washed while supported over the tank, but in addition a spray nozzle must generally be used to clean inaccessible places. The armature must be wiped as dry as possible. Spraying should be reduced to the minimum. The object of the tank is to collect the gasoline, which can be used over again until dirty.

To remove the mixture of oil and gasoline and prepare the insulation for painting, the field coils and armature should be dried in an oven at a temperature of 200 deg. F. If this is impracticable it may be dried in a warm room, or, if the weather is warm, in the sunshine. After drying, the insulation is again wiped clean. If conditions permit, the field coils and armature should be

dipped in an oil-resisting varnish. The shaft and commutator must be well covered with paper if dipped. Or the insulation may be painted with a brush. But a spray nozzle is preferable. If baking varnishes are used drying must be done in an oven.

If the insulation has become saturated with oil, it is almost impossible to completely remove it; consequently, new insulation should be applied. Gasoline, an excellent solvent for most mineral oils, is generally used to clean insulation. It is cheap, readily obtainable, quickly evaporates, and is harmless to most insulating materials. Gasoline must be applied sparingly to insulations that have been treated with varnish for which it is a solvent. Its high inflammability is a recognized source of danger; hence gasoline must be used with caution.

Carbon-tetrachloride is sometimes used for removing oil from insulation, and is very effective, besides being noninflammable. Occasionally a solution of half gasoline and half carbon-tetrachloride is employed. Other cleaning fluids are obtainable. I understand that motors in sugar mills are cleaned by washing with water, then drying to remove the moisture. R. M. REED.

Oakland, Calif.

I HAVE FOUND that compressed air is the most satisfactory medium for cleaning field coils and armature windings. The air must be dry and the pressure not high enough to injure the insulation. Rotate the armature slowly if possible and after the oil, dust and loose dirt have been blown off, clean the windings with benzine. Care must be taken not to have an open flame near, because it may cause an explosion.

I use a 3-gal. kerosene blow-torch tank in which is 1½ gal. of benzine, and spray the coils and armature with 30-lb. air. After this treatment dry air is used to blow out all the loosened dirt and oil. This process is repeated until the windings are clean. After cleaning, the armature and field coils are given plenty of time to dry. When the insulation has been cleaned a coat of insulating varnish is applied. After this has had time to dry a second coat is applied. This treatment gives a satisfactory job. The use of wire brushes or any device that is liable to injure insulation should be avoided. JOE MARTENSEN.

Westfir, Ore.

TO RESTORE the insulation of armature windings and field coils that have become oil soaked, blow steam on them, using saturated steam of about 125-lb. gage. Blow the windings and coils until all grease and dirt are removed. They should then be put in an oven to dry out the moisture, after which they are ready to be revarnished and baked. We have about 800 motors in our plant, where this method has been used successfully and has been found to be much better than using gasoline and compressed air. L. R. MOHLER.

Alton, Ill.

SEVERAL methods can be used for restoring oil-soaked insulation. The coils can be washed with gasoline, in many cases, although there are better and safer cleaning fluids on the market. With machines too large to take to the repair shop this is the only practicable way. In extreme cases the coils might have to be retaped, particularly the outer layer.

The best method in the average case is to put the coils or armature in an impregnating tank. At each of our shops we have one of these tanks in which the coils can be heated and then the impregnating compound forced in under pressure. The baking volatilizes the oil and the impregnating restores the insulation and makes it difficult for oil to again injure the machine.

F. FRASER MACWILLIAMS.

Spangler, Pa.

THE BEST way to restore insulation of coils that are oil soaked but not burned, is: First, wash them thoroughly, using carbon-tetrachloride, applied with a rifle or revolver cleaner that will shoot the cleaning fluid into all the small places. When the cleaning has been completed let the insulation thoroughly dry, after which apply a good insulating paint, using a spray gun so that it reaches all of the coils. The gun will be much better than a brush for cleaning. Never use gasoline, because it may ignite and ruin the windings. Carbon-tetrachloride is not dangerous, as it is a fire extinguisher and evaporates rapidly. HARRY L. BEHMER.

Logansport, Ind.

IN OUR plant we use gasoline exclusively for cleaning insulation, because it cleans thoroughly, dries quickly and will not injure the windings in any way. The oil and dirt is scrubbed off with a small paint brush soaked with gasoline. After cleaning and drying the windings are tested with a Megger, and if they do not show fairly good insulation the cleaning process is repeated.

Sometimes it is necessary to dry the coils or armature by heating in an oven or by allowing current to flow through them. After this the armature or coils are painted with an insulating varnish. When the varnish is dry the final Megger test is given. In many cases we have brought the insulation resistance from zero to twenty megohms.

Boston, Mass. E. R. SHEQUINE.

WHEN the windings of direct- or alternating-current motors and generators become oil soaked, the only sure method of driving out the oil is by heating them. Gasoline will clean the surface of the windings but will not remove it from the slots or the interior of the winding. On small machines, baking in an oven at a temperature not exceeding 225 deg. F. will evaporate the oil, after which the windings should be dipped in insulating varnish while hot.

On larger machines, where it is not feasible to remove the parts, a heavy current at reduced voltage may be applied to the windings to evaporate the oil. Thermometers should be placed at various points in the windings and against the laminations, and a careful watch must be kept to see that the temperatures do not exceed the safe value, otherwise the insulation will become roasted and brittle. A temperature of 225 deg. F. will cause the windings to smoke considerably, but no notice need be taken of this, as it is only the oil evaporating. When the windings cease smoking, insulating varnish should be applied, while the windings are hot, either by a spray gun or brush.

H. E. STAFFORD,
Electrical Engineer,
Provincial Paper Co.

Port Arthur, Ont.

IF THE machine is oily and dusty, it should be dismantled, the windings scraped with tools that have no cutting edges, and then washed with gasoline or naphtha, using a stiff bristle brush. A nozzle arranged for air and naphtha similar to that used for spraying paint can be used to advantage.

I have obtained satisfactory results by squirting a stream of gasoline from a blow torch into the winding. When applied in this way, gasoline penetrates the small spaces that cannot be reached with a brush. At the same time, the windings are not soaked, as is the case when they are dipped in gasoline. Spraying is the best method, because it can be directed to any part of the winding. The dirt and oil will be loosened and blown out without harm to the winding, and the gasoline will soon evaporate. When the winding is thoroughly cleaned a good grade of air-drying insulation varnish should be applied.

HARRY J. ACHEE, *Supt.*,
Hobart Light & Water Co.

Hobart, Ind.

A Question for Our Readers

I HAVE a 125-hp., 675-r.p.m. induction motor that is to be used to drive a 100-kw., 600-r.p.m. compound-wound direct-current generator. Can these two machines be operated satisfactorily if they are directly coupled together? What is the best way of controlling the excess voltage of the generator due to the high speed? Has the increase in speed any effect on the compounding of the machine? W.B.

Suitable answers from readers will be paid for and published in the Oct. 28 number

Coal for Pulverizing and Burning*

By E. G. BAILEY
President, Fuller Lehigh Company

THE IDEAL METHOD of burning coal would be one in which its impurities or burning characteristics would not interfere with obtaining its best capacity and efficiency. If this were so, then coal could be purchased on a basis of its heating value alone. The development of pulverizing equipment today is along the line of reaching this goal. Some of the earlier pulverizing equipment fell short in that it required coal of high grade and high ash-fusing temperature to obtain reasonably high rating and give satisfactory life to the brickwork, and the removal of ash. Recent improvements in burners and water-cooled furnaces have revolutionized this situation.

When coal is pulverized and burned in suspension it becomes so uniform as to size and burning properties that more nearly equal efficiency and capacity is obtained from all kinds of coal. The price and the heating value more nearly cover the complete requirements in its selection.

Moisture is objectionable in pulverizing and transporting pulverized coal, and dryers were almost always installed in the earlier plants, especially those of the bin system. Today it is quite customary to dry the coal in the mill while pulverizing. With the prevalent use of air preheaters in steam plants, plenty of hot air is available and is supplied directly to the air-swept mills at a temperature of 250 to 450 deg. F., and coal with any reasonable amount of moisture, up to 10 or 15 per cent, can readily be handled at no additional cost other than the heat required to evaporate the moisture.

Fuels with low volatile, such as anthracite and coke, can successfully be burned in the same furnace that is used for higher-volatile coals. The highest-volatile coals can readily be burned without smoke or unburned gases. So volatile is not in itself a limiting factor, although low-volatile coals, 6 per cent or less, cannot be burned efficiently in "cold" or completely water-cooled furnaces or with high-velocity turbulent burners.

The percentage of volatile and fixed carbon are closely associated with the coking or free-burning characteristics of a fuel. A wide range of coals can be burned equally well in pulverized form with little attention to these factors. As a rule, the lower the percentage of volatile the slower the rate of combustion, hence a larger furnace and longer flame travel is required to prevent carbon loss. If there is any unburned fuel or smoke resulting from burning pulverized coal in too cold a furnace or because of improper air supply, it is in the form of carbon and not "CO" (carbon monoxide) or unburned gases.

The fusing temperature of ash is the one factor which must be given consideration when buying coal to be burned in pulverized-coal-fired furnaces with refractory walls. Modern development in water-cooled furnace walls and slag-tap furnaces where ash is removed in the molten state have removed practically all limitations regarding the percentage of ash and its fusing temperature.

The furnace shown in Fig. 1 has operated satisfactorily when burning coal having an ash of 2,700 deg. F. fusing temperature, and the rating is limited to 16,000 B.t.u. per cubic foot. If coal of lower fusing temperature were to be burned in this furnace the rating would have to be reduced correspondingly to prevent erosion of the brick walls and clogging of the ash hopper.

This furnace has lately been modified, as shown in Fig. 2, to include a block-covered water-cooled front wall. With this design the rating has been increased from 16,000 to 20,000 B.t.u. per cubic foot of furnace volume without any furnace trouble on the other walls when burning coal with ash of 2,700 deg. F. fusing temperature.

Fig. 3 is a furnace burning pulverized

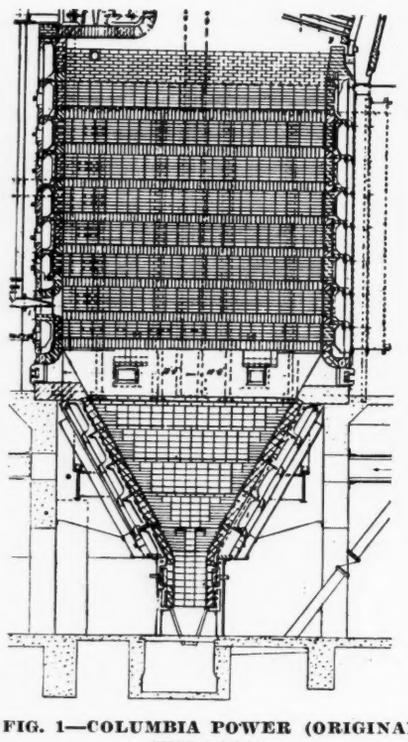

FIG. 1—COLUMBIA POWER (ORIGINAL FURNACE)

(*a*) Kind of coal, Logan County, W. Va. (*b*) Analysis (dry basis): Volatile, 32.37; carbon, 57.16; ash, 10.47; sulphur, 0.70; B.t.u., 13,900; ash-fusing temp., 2,700 deg. F. (*c*) Boiler rating, 360 per cent. (*d*) B.t.u. / cu.ft. / hr., 16,000.

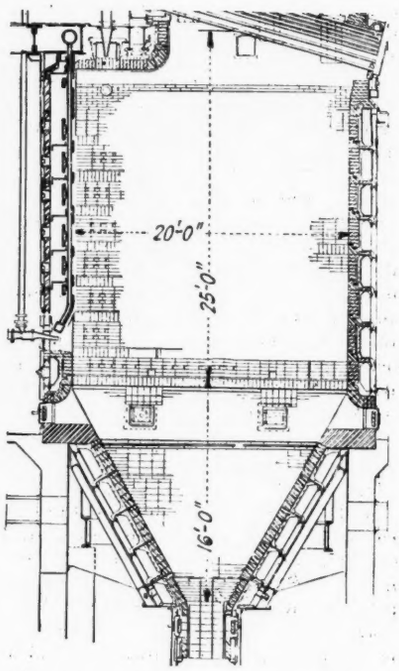

FIG. 2—COLUMBIA POWER (WATER-COOLED FRONT WALL)

(*a*) Kind of coal, Logan County, W. Va. (*b*) Analysis (same as Fig. 1). (*c*) Boiler rating, 450 per cent. (*d*) B.t.u. / cu.ft. / hr., 20,000.

GRINDABILITY AND WEAR WITH 7 DIFFERENT COALS

Coal	A	B	C	D	E
Kind of Coal	Penna. Bit. (Clearfield Co.)	W. Va. & Pgh. Bit.	Ill. Bit.	Penna. Anth.	W. Va Bit. (Logan Co.)
Grindability index	88	65	52	44	34
Relative grinding capacity in per cent	100	94	88	82	75
Relative life of wearing parts in per cent	52	100	27	6	77

*Excerpts from paper before the National Association of Purchasing Agents, Inc., at Chicago.

anthracite coal of 10,500 B.t.u. per cubic foot without trouble from wall erosion, but considerable trouble was encountered in removal of ash with only the small amount of water cooling supplied by the water screen. A water-cooled ash hopper, Fig. 4, consisting of 3¼-in. tubes on 6-in. centers and covered with smooth-faced cast-iron blocks clamped tightly to the tubes has eliminated all trouble in removing ash and permits a longer flame to be carried. The coal has 18 per cent ash and is of 2,500 deg. fusing temperature.

Fig. 5 illustrates an industrial installation with three sides of the furnace water cooled and a water-cooled hopper bottom. Coal having an ash content of 6.8 per cent and 2,300 to 2,600 deg. F. fusing temperature is successfully burned in this furnace at ratings up to 28,400 B.t.u. per cubic foot without excessive furnace maintenance.

As the complete water cooling of furnace walls is becoming almost universally adopted for both pulverized coal and stoker-fired furnaces, it has been logical to carry the rates of heat liberation up to relatively high values, that is, more than 30,000 B.t.u. per cubic foot. At these ratings practically all ash becomes molten, and by properly designing the floor of a pulverized-coal-fired furnace the ash accumulates in a molten pool and is tapped out in a stream of slag, like the discharge from a blast furnace. A furnace of this type is shown in Fig. 6. It handles coal having an ash content of 15 per cent and a fusing temperature of 1,900 to 2,100 deg. F. A furnace of this kind recovers from 35 to 50 per cent of the total ash fired with the coal, compared with only 5 to 15 per cent ash being recovered from a furnace like that shown in Fig. 1.

With properly cooled hopper or slag-tap furnaces it is possible to burn coal with high ash and low-fusing temperature as readily as the higher-fusing-temperature ash coals which usually command a premium because of their demand for stoker and hand-fired furnaces. Coals with high sulphur, high ash and low-fusing temperature have usually been a drug on the market and are available at correspondingly lower prices. These later developments in pulverizing equipment and furnace design make them available for consideration on a basis of their heating value.

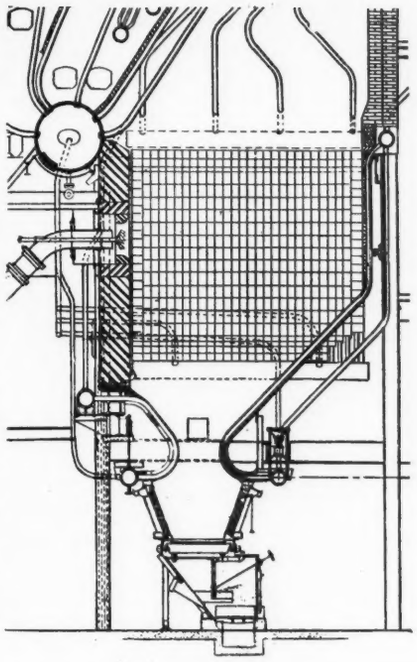

FIG. 5—PAUL SORG

(*a*) Kind of coal, Ind., Ky. and W.Va. bituminous.
(*b*) Analysis (dry basis) (Hazard Seam, Ky.): Volatile, 35.28; carbon, 57.92; ash, 6.80; sulphur, 0.70; B.t.u., 13,430; ash-fusing tem., 2,300-2,600 deg. F.
(*c*) Boiler rating, 415 per cent.
(*d*) B.t.u. / cu.ft. / hr., 28,400.

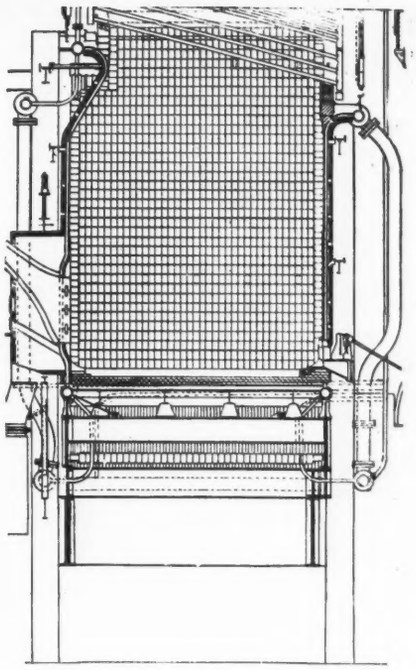

FIG. 6—STATE LINE (SLAG-TAP)

(*a*) Kind of coal, Central Illinois.
(*b*) Analysis (dry basis): Volatile, 37.42; carbon, 47.54; ash, 15.04; sulphur, 5.58; B.t.u., 11,600; ash-fusing temp., 1,900-2,100 deg. F.
(*c*) Boiler rating, 1,375 per cent.
(*d*) B.t.u. / cu.ft., 34,300.

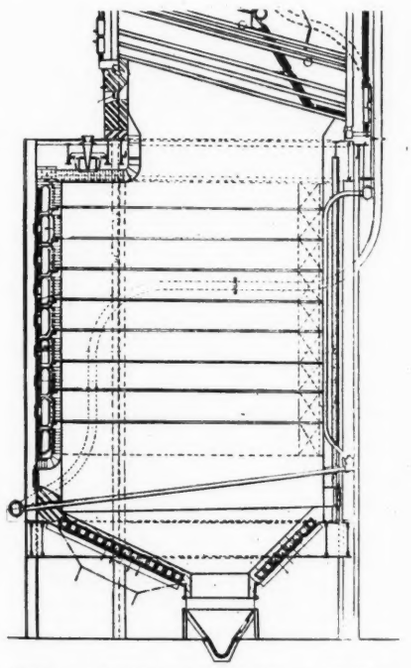

FIG. 3—PINE GROVE NO. 7, WITH WATER SCREEN

(*a*) Kind of coal, Pa. anthracite.
(*b*) Analysis (dry basis): Volatile, 8.87; carbon, 72.93; ash, 18.20; sulphur, 0.68; B.t.u., 12,116; ash-fusing temp. 2,500 deg. F.
(*c*) Boiler rating, 350 per cent.
(*d*) B.t.u. / cu.ft. / hr., 10,500.

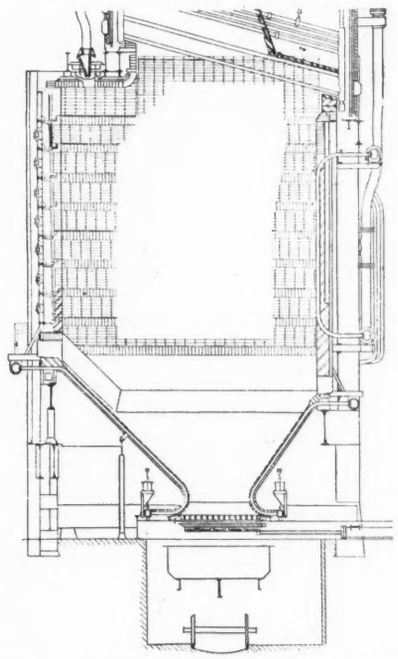

FIG. 4—PINE GROVE (WATER-COOLED HOPPER BOTTOM)

(*a*) Kind of coal, Pa. anthracite.
(*b*) Analysis (same as Fig. 3).
(*c*) Boiler rating, 412 per cent.
(*d*) B.t.u. / cu.ft. / hr., 12,000.

Pulverizing of Coal

There is another problem in the selection of the type of pulverizer mill best adapted to pulverize different kinds of coal or the selection of coal with respect to its pulverizing capacity and cost after pulverizing equipment is installed.

Some coal is much softer than others and has a correspondingly higher grindability index. This means that for a given mill greater capacity can be obtained than if a harder coal with a lower grindability index were being used. There is a corresponding difference in the power required per ton of coal pulverized to a given standard of fineness.

The amount of abrasion or wear of grinding elements also varies widely with different kinds of coal. In general, the harder the coal and lower the grindability index the greater the wear per ton, but this does not always follow, as there are some relatively hard coals that cause very light wear on the grinding parts. There are also some coals which have enough pyrites, etc., to cause considerable wear, yet the quantity does not materially affect the grindability when the coal itself is very soft.

The table gives some relative data regarding grinding capacity and wear as represented by results from different kinds of coal being pulverized in one type of mill.

All types of mills are not equally affected by either the grindability index or by wear. While it can never be hoped to realize the same capacity from a given mill with all kinds of coal, the rating of mill capacity for coals of different grindability should be better established than it now is. Work is now in progress along these lines.

After these points are cleared up and a grindability index established, its determination for different coals will enable better selection to be made by the purchaser where pulverizer mills of limited capacity are installed. Enough is already known that no serious difficulties are encountered except in the case of anthracite and a few bituminous coals that have proved unusually hard to grind.

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Bradford Station in England Goes to 1,100 Lb. Steam Pressure

IN EXTENDING its Valley Road power station, the City of Bradford, England, has added a high pressure section to operate at a steam pressure of 1,100 lb. and at a temperature of 800 deg. F. The first instalment of a general description of this station, with comments on the design, appeared in the Sept. 5 number of *The Engineer* (London). In the same number appeared an editorial that should be of interest to American engineers, as well as to British readers of *The Engineer*.

Except for an experimental Benson boiler, erected some years ago and later passed along (in principle) to the Continent for further development, the Bradford station carries by far the highest pressure of any British installation. Its nearest competitor, as pointed out in *The Engineer*, is a plant of the Imperial Chemical Industries, where the boilers now work at 815 lb. The same article states that a 1,250-lb. installation is contemplated by the Ford Motor Company, Ltd.

With this installation, the Bradford station becomes in reality, a two-pressure plant, like the Edgar station in this country. The new high-pressure turbine exhausts to existing moderate-pressure steam headers and turbines.

Judged by American standards of size, the Bradford installation is small. Its single boiler has a maximum continuous evaporation of 94,000 lb. per hour. Including 810 sq.ft. of water wall heating surface, the total water heating surface is 9,175 sq.ft. The superheating surface is 2,013 sq.ft., and that of economizer and air heater 8,412 sq.ft. and 16,400 sq.ft., respectively. Water-heating surface is a much higher percentage of the total than in the latest American 1,400-lb. plants. This boiler is fired by a chain-grate stoker.

The high-pressure turbine exhausts to a desuperheater at a pressure of about 200 lb. per square inch. It is then reheated to 755 deg. before passing to the low-pressure mains.

Following present American 1,400-lb. practice, the drum is of solid steel forged from a single ingot. Its length is 28-8¾ in., internal diameter, 3 ft.-7 5/16 in., and wall thickness 3 7/16 in.

The editorial in *The Engineer*, parts of which are quoted below, points to this installation as an example of a new progressive spirit in the British power circles and urges British engineers more generally to step to the front in power developments, thereby achieving economies in power production, enhancing their prestige and improving the competitive position of British manufacturers of power equipment.

The editorial says, in part:

. . . "It is true that the Benson boiler, generating steam at the critical pressure of 3,200 lb. per square inch, was first built and operated in England, but failing to find a congenial home here, the system was brought to maturity on the Continent. Except for this one, rather questionable, example, British enterprise as regards high-pressure steam seemed to have been almost wholly lacking since the far-off days when North Tees established a record with a boiler pressure of 475 lb. per square inch. Such a state of affairs was by no means creditable to British prestige. We are certainly developing power station practice to an exceptional degree of efficiency and reliability in the field of moderate pressures, but our neglect to explore the greater possibilities which theory held out to us in the use of very high pressures showed a disquieting lack of initiative. It was, moreover, bound to have an unfortunate repercussion on the business of our manufacturers. With plant for higher and higher pressures being demanded by foreign users, our makers of boilers, turbines, piping, feed pumps, superheaters, valves and fittings were all obviously handicapped. They could hardly hope to compete with foreign rivals who were able to point to work successfully carried out and who could place their manufacturing and operating experience so acquired at the service of their customers. Business goes to the firms which lead, and their enterprise is rewarded by a highly profitable market so long as they are known to hold the monopoly of experience in any new development. Conversely, the firms which have only made what anybody can make, must struggle for such orders as they can get, for, however great the excellence of their standard products may be, such firms are at a manifest disadvantage when tendering in a market which calls for goods in the manufacture of which they have had no experience.

"This is a point which we would like to drive home. To succeed commercially we must at least retain, if not recover, the lead in design which we held a generation or more ago. It is a fatal policy for a firm to allow rivals to get ahead, and then to think it can acquire their experience by manufacturing their designs under license. Even if it were possible to buy experience—which it is not—the firm which follows in design is necessarily behind. . . .

"The position we would like to see would be that of British firms leading more generally in original design and acquiring the prestige and revenues which such a lead entails. It is easy to lay the blame on manufacturers when a lack of enterprise seems evident, but it is only right to be fair to them. Two parties are necessary to the realization of every advance in engineering, one to give the order and the other to carry it out. Unless there are customers available for an expensive plant of a new type, makers can hardly be expected to develop it. . . .

"Bradford is an example of the enterprise we wish to see, a genuine effort by British manufacturers to demonstrate that they are able, from their own technical and manufacturing resources, to take their place among the pioneers of high-pressure and high-temperature steam plant. The whole installation, including boiler, turbine, and all auxiliary plant and apparatus, is of British design and British make, so that we have now had taken from us the reproach of having nothing of our own to talk about when very high-pressure steam is under discussion. That the plant will fulfill the anticipations of its designers we have no doubt whatever. We trust that it will even exceed them. But whatever its performance may be, its installation will have been more than justified by the lessons of design that it will teach. It marks, for the central station practice of this country, a definite step in progress, and all the manufacturers concerned in its production will henceforth be in a position to undertake with greater confidence the development of their particular apparatus. Mr. Roles and the Bradford Corporation, for their part, are likely to have the advantage of possessing a particularly efficient addition to their power station. They will have, moreover, the satisfaction of having accomplished something for the benefit of British industry. Their willingness to take a certain risk for the advancement of their electrical undertakings provided the manufacturers with the chance to show what they could do."

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AUGUST SALES of mechanical stokers, as reported to the Department of Commerce, totaled 115 with 29,933 hp., as compared with 150 of 37,761 hp. in July.

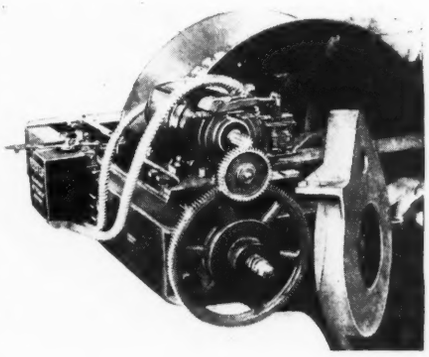
WHAT'S NEW IN PLANT EQUIPMENT

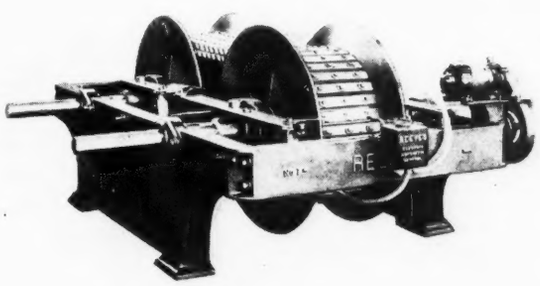
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Electric Automatic and Remote Controls for Variable-Speed Transmission

IN THE May 17, 1927, number of *Power* a remote electric control for Reeves variable-speed transmission put out by the Reeves Pulley Company, Columbus, Ind., was illustrated and described. This control was designed to permit regulation of the speed of the transmission from any one of a number of positions remote from the transmission itself.

To make possible accurate synchronizing of a series of machines or sections of a machine automatically, or regulating the speed of travel to compensate for varying operating conditions a new electric automatic control and electric remote control have recently been introduced. The new controls are especially adapted to such uses as the regulation of stoker speeds based upon fluctuation of steam pressure or regulation of pumps based on back pressure or level of liquid in a tank, as well as a wide range of application to machines used in industrial processes.





Two views of variable speed transmission equipped with electric automatic control

The new controls embody a specially designed two-way mercury switch arranged for automatic operation from a regulator or moving part of the machine to be controlled and a solenoid brake to stop the speed-adjusting motor immediately and prevent coasting or over-travel of the shifting screw.

In the two-way mercury switch, which is shown mounted on the front of the unit, four mercury switch tubes are carried in spring clips on a special rocker arm. The arm is moved in either direction by a toggle joint with two extended levers, one a contact lever connected to a master regulator or moving part of the machine to be controlled, and the other a contact-breaking lever joined by a connecting rod to one shifting nut of the transmission. When the two levers are in a straight line all contacts are broken. Also, when the current is cut off from the motor it is cut off from the solenoid coil and the brake is set by a tension spring. Arrangement of the controlling motor with automatic switch and details of the drive between the motor and shifting screw are clearly shown in the illustration.

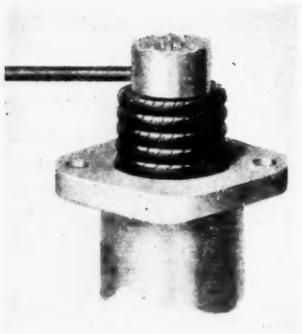
The two controls (remote and automatic) are identical, with the exception of the switch. In the remote control, in place of the two-way mercury switch, a special push-button station with "fast" and "slow" buttons to operate the motor in either direction is furnished. These push buttons also operate the solenoid brake. The stations may be located at any distance from the machine and two or more may be used. Where two or more transmissions equipped with electrical remote control are installed they may be controlled in synchronism from one master push-button station, and each transmission may also have an individual station. Where desired these stations can be grouped on a control panel together with electric tachometers to show the speed of each unit.

Semi-Metallic Packing in Rod Form

INSTEAD of being wound on spools or manufactured in coil form, as is the usual practice, a semi-metallic packing known as "Cordex" now being put out by Metalastic, Inc., Union City, N. J., comes in straight rods 18 in. in length.

According to the manufacturer the packing is composed of metal particles, asbestos fiber, binder and a specially prepared lubricant, the whole being incased in a thin shell of viscous material. The wrapping is said to be just strong enough to endure handling, and after the packing is placed around the rod, inserted in the stuffing box and the gland drawn up, it disrupts, permitting the packing to readily adjust itself to fit the box regardless of shape or size.

The new packing is suitable for use with steam, water, oil, gas, ammonia, alcohol, brine and acids. One



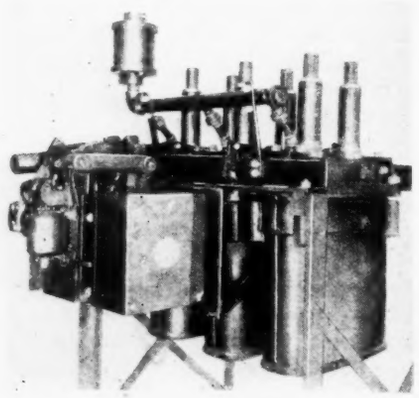
Cordex packing being wound on rod

of the principal advantages claimed for it is that it fits any stuffing box, small sizes being suitable for fitting large boxes. It is available in all sizes from $\frac{3}{16}$ to 1 in., packed in 18-in. lengths in cartons from 5 to 20 lb. For low temperatures up to 500 deg. Gray Seal is used, and for higher temperatures up to 1,200 deg. Red Seal is recommended.

Oil Circuit Breaker for Indoor Service

DESIGNED for indoor service only and especially for use in power plants and substations where a small space is available for switching equipment, the new line of oil circuit breakers recently added to the line put out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is rated at 15,000 volts and 400 to 2000 amperes. Four types comprise the new line.

These breakers are manually or electrically operated, and are available



Circuit breaker for power plant and substation service

with one, three, or four poles, single throw. They are designed for truck or structural frame mounting and are readily applicable to cell mounting.

Improved Line of Synchronous Motors in Sizes From 20 to 10,000 Hp.

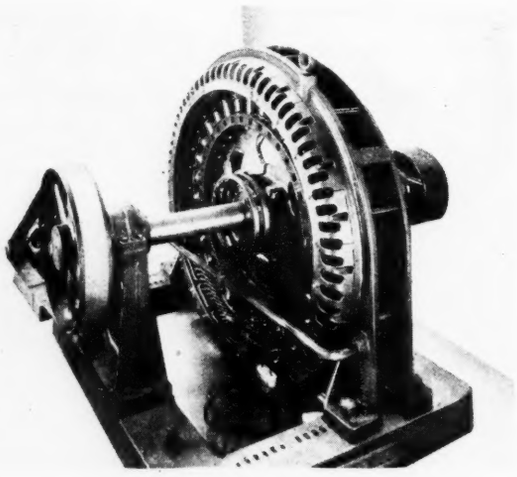
IN EXTENDING its line of synchronous motors to cover a range of ratings from 20 to 10,000 hp. Fairbanks, Morse & Company, Chicago, Ill., have introduced a number of refinements in synchronous motor design.

The stator has cast semi-steel skeleton frame ends of nutless, boltless, and threadless construction. Laminations in the stator are stacked on circular threadless stacking pins, and compressed under high pressure, the stacking pins being finally welded to form a flat countersunk head. Laminations of the pole pieces are also assembled under high pressure and are securely riveted together. In all except the smaller sizes, the field coils are made of copper strap wound on edge. The squirrel-cage winding for starting consists of copper, brass, or special bronze-alloy rods or a combination of these inserted through holes near the face of the polepieces. End ring connectors are arranged to permit of removing any pole without disturbing the others, and the connectors between poles are shaped to provide additional ventilation for both the rotor and stator.

A full line of pedestal-type motors is also offered for the first time equipped with anti-friction bearings. The smaller and intermediate sizes are fitted with ball bearings and the larger slow-speed machines with spherical bearings. Sleeve bearings are optional.

Some of the electrical characteristics embodied in the new motors, according to the manufacturer, are, better-than-ordinary efficiencies at full and partial load; high starting and pull-in torques, resulting in more rapid acceleration; in-rush kilovolt-amperes of the standard motors held to limits which permit all motors of this type to be started at full voltage on any but the smallest systems; temperature rise when operating under full rated load continuously will not exceed 50 deg. C. on either field or stator windings.

The type of starter required is comparatively simple, being similar to the across-the-line starter used for small and medium-sized induction motors, with the addition of a relay-actuated automatic field switch which closes the field circuit at a predetermined point as the motor approaches synchronous speed. The field switch opens automatically when the motor stops. For certain conditions auto-transformer starters for reduced voltage starting may be had of either semi- or full-automatic types.



Improved synchronous motor with anti-friction bearings and belt-driven exciter

New Arc-Welding Wire

A NEW welding wire known as Wilson Red Processed Arc-Welding Wire is announced by Wilson Welder & Metals Co., Inc., P. O. Box 96, North Bergen, N. J. This wire is said to combine a fast and smooth-flowing quality, with good penetration. It will produce a weld of at least 50,000 lb. per square inch tensile strength, and is especially recommended for general welding operations where medium ductility is required.

NEWS of the FIELD

Spot News

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NATURAL GAS *will soon be distributed in Washington, D. C., and other cities on the Atlantic seaboard, according to an announcement made last week by officials of the Columbia Gas & Electric System. Transmission of natural gas to York, Pa., over present lines of the system has been approved, and plans are under way for the extension of these lines through West Virginia and Virginia to cities on the East Coast.*

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CONSTRUCTION *of a $25,000,000 power project on the Tennessee River near Asheville, N. C., has been recommended to Congress by the corps of engineers of the United States Army under the general program to improve the Tennessee and its tributaries for navigation, flood-control and hydro-electric power development, it was announced last week at the United States Engineer's office in Chattanooga, Tenn.*

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A LOW-COST RECORD *for highway freight transport has just been established by a one-ton truck powered with a Hill four-cylinder 3½ x 6 Diesel engine. On a 1,478-mile round trip between Lansing, Mich., and Nyack, N. Y., with load, the total cost of fuel was $5.02, an average of $0.00339 per mile. This is the first long-distance service run ever made by an American Diesel-powered truck.*

•

ALL COSTS *associated with the merchandising business of public utilities, regardless of the motive which impelled the company to enter the merchandising field, must be charged to a separate account and not taken into consideration in arriving at rates to be charged for service, according to an order just issued by the Wisconsin Railroad Commission.*

Packard Laboratory to Be Dedicated at Lehigh University on Oct. 15

Conferences on relation between technical schools and industries and the future of American industry to follow ceremony on Oct. 16-17.

FORMAL DEDICATION of the new James Ward Packard Laboratory of electrical and mechanical engineering at Lehigh University, Bethlehem, Pa., will take place on the afternoon of Oct. 15. Following the dedication ceremony there will be a two-day conference on the relations between technical schools and the industries and the future of American industry. Leaders of engineering education, research and industry will be heard at both meetings, covering the three days from Oct. 15 to 17.

The dedication ceremony will start at 2:30 p.m. on Wednesday, following registration of delegates in the morning and a luncheon for representatives of institutions and associations at noon President Charles Russ Richards of Lehigh University will deliver the introductory address. Theodore Cuyler Visscher of the architects will give a description of the laboratory building and will present the keys to Dr. Eugene Gifford Grace, president of the board of trustees of the university. The dedicatory address will be made by Charles M. Schwab.

In the evening S. M. Kintner, assistant vice-president in charge of research of the Westinghouse Electric & Manufacturing Company, will give a demonstration lecture at the laboratory.

The conference on the relation between the industries and the technical schools will open on Thursday morning with a session devoted to "What Industry Expects of the Technical Schools." Outstanding representatives of the manufacturing, transportation, automotive and communications industries will present their requirements and expectations. Matthew S. Sloan, president of the New York Edison and associated companies, will deliver a paper on "What the Public Utilities Expect of the Technical Schools."

In the afternoon Dexter S. Kimball, dean of the College of Engineering at Cornell University; Dugald C. Jackson, head of the department of electrical engineering at the Massachusetts Institute of Technology; and David Ross, president of the board of trustees of Purdue University, will tell what the technical schools expect of industry. At this session Dr. William E. Wickenden, president of Case School of Applied Science, will present a paper on "The Relations Between the Industries and the Technical Schools in Europe."

On Friday morning a conference will be held on the future of American industry, at which Magnus W. Alexander, president of the National Industrial Conference Board, will discuss "The Future of Industry, Its Problems and Needs"; Edward A. Filene, president and chairman of the board of William Filene's Sons' Company, will talk on "Distribution and Its Effect on Industry"; Dr. John Johnston, director of research of the United States Steel Corporation, will outline "The Effects of Research on the Future of Industry"; and S. L. Andrew, chief statistician of the American Telephone & Telegraph Company, will tell about "The Methods of Industrial and Business Forecasting."

Boulder Project Started; Renamed Hoover Dam

On Wednesday afternoon, Sept. 17, Ray Lyman Wilbur, Secretary of the Interior, formally started work on the $165,000,000 Boulder Dam, and announced that the Colorado River project would be known as the Hoover Dam in honor of the President.

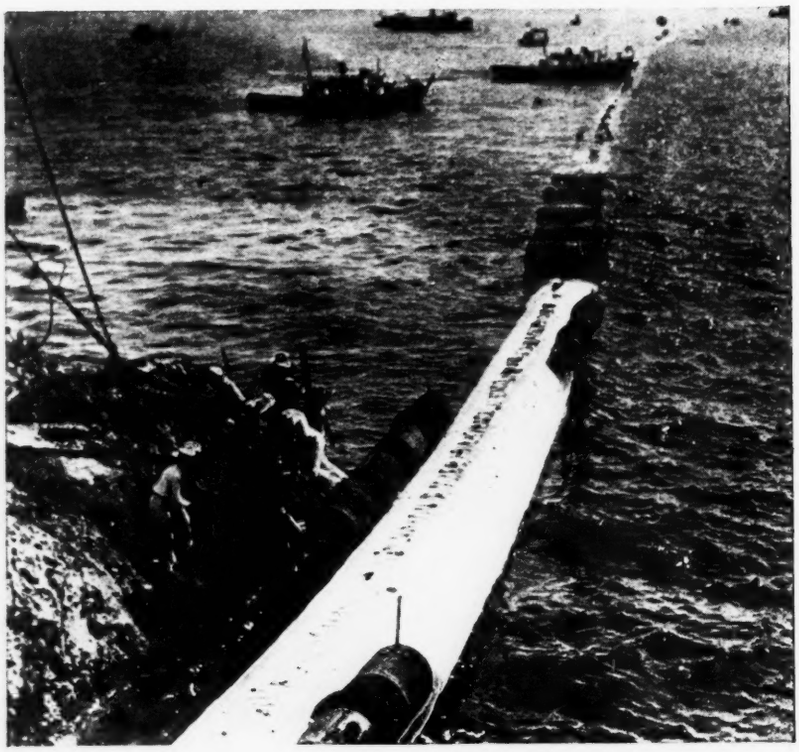
Announcement of a name to be attached to the huge engineering feat was made by Secretary Wilbur after he sledged a spike of Nevada silver into a railroad tie. The railroad will be used to haul material to the dam site.

"I have the honor," he said, "to name this dam after a great engineer who really started this greatest project of all time—the Hoover Dam."

Officials from six Colorado River Basin States—Nevada, California, Colorado, Utah, New Mexico and Wyoming—attended the ceremony.

Secretary Wilbur expressed the belief that the project would be paid for by the power it developed, but that, of even more importance, the waters of the river would be used for irrigation.

LOWERING CLAUDE'S POWER PIPE



The third attempt of Professor Georges Claude, French scientist, to sink a corrugated steel pipe more than a mile long and 6 ft. in diameter in hope of developing cheap power from the warm and cold waters of the Gulf Stream succeeded. The section shown above is being lowered to the bottom of Matanzas Bay, Cuba, 1,800 ft. down

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Tentative Program Set for Midwest Power Conference

On Sept. 11 President H. W. Fuller announced definite acceptance of the tentative program for the fifth Midwest Power Engineering Conference to be held in Chicago, Feb. 10 to 12, 1931. Co-operating with Mr. Fuller, the program committee, headed by Thomas Wilson, western editor of *Power*, had prepared an outline of procedure that will assure an assembly of subjects covering a broad expanse of the power field. Held in conjunction with the National Fuels Meeting of the American Society of Mechanical Engineers, the conference will afford the unusual opportunity of attending two major engineering meetings devoted to the power field and a display of the latest developments in equipment.

Opening officially with a luncheon devoted to the influence of power on modern development and progress, the power conference will continue through six sessions. There will be a session on power economies dealing with the balancing of plant investment and the advance in electrical distribution from the standpoint of design, construction and operation, with a third paper on the commercial distribution of high-pressure steam.

An evening meeting on refrigeration and ventilation will feature recent applications of refrigeration in air conditioning and the power requirements in the general cold-storage industry.

Under prime movers, papers will be devoted to late trends in the development and application of steam turbines, reciprocating engines for the higher pressures, diesel engines and water turbines of the propeller type.

At a luncheon high-temperature metals will be discussed. In the electrical field subjects of decided current interest will be treated. The papers will deal with the electrical pumping of oil, gas and gasoline; electrical arc welding in the power plant, and high voltage direct-current transmission.

A session on the water problems of the power plant will bring out late developments in the pretreatment of boiler feed water, recent evaporator practice, and design and concentration control of boiler water.

For the final session, which will be devoted to civil engineering, a topic of universal interest has been reserved, the engineering features of the Chicago subway. A second paper will give the audience a taste of geology, for it will deal with natural power resources.

A composite program of both meetings listing papers and authors specifically will be available soon.

Leaburg Plant Chosen as Architectural Type

The Leaburg hydro-electric plant of the City of Eugene, Ore., was chosen as typical of Oregon hydro-electric plants in a selection of typical architecture throughout the state by a committee from the Oregon chapter, American Institute of Architects. The subjects considered included homes, industrial plants, public and commercial buidings and statuary, with a sample of each chosen as being representative of its field. The survey, which is national in scope and conducted by the Chicago *Tribune*, will place the buildings chosen from Oregon in competition with those from every other state of the Union.

The Leaburg power plant, recently completed by the City of Eugene, was designed for 20,000 hp. in two units by Stevens & Koon, consulting engineers, Portland. Ellis F. Lawrence, dean of the School of Architecture, University of Oregon, Eugene, is responsible for the architectural treatment, which found so much favor with judges of the contest.

New Hydro Projects in Alaska, Calif. and W. Va.

Plans for the construction of a hydro-electric development at Hyder, Alaska, costing $3,000,000 and having an ultimate capacity of 20,000 hp., have been announced by the Portland Canal Power Company of Seattle, Wash., which has been organized to carry out the project. The plans call for a power tunnel 800 ft. long and steel penstock pipes 400 ft. long to deliver the water to turbines in a concrete power house. A reservoir two miles long will be created. The Federal Power Commission has granted the preliminary power permits, and actual construction will start as soon as plans are completed and the field work done.

The commission also authorized the issuance of a preliminary permit to the Pacific Gas & Electric Company for the investigation of a prospective development of 34,000 hp. on Bear River, Calif., which would supplement the extensive project now being constructed by the company on the Mokelumne River.

The South Branch Power Company of Philadelphia has filed an application with the commission for a preliminary permit covering a 25,000-hp. project on the south branch of the Potomac River and on the Cocapon River in West Virginia. This is a portion of the original project filed by the company, which included dams on the Potomac and Shenandoah Rivers. Power development on the Potomac is precluded by the act creating the George Washington Memorial Parkway. Under the revised project it is planned to build four dams on South Branch and two dams on the Cocapon.

National Power Show Plans Shaping Up

Preliminary details of the ninth National Power Show, to be held at the Grand Central Palace in New York City on Dec. 1 to 6, are well under way, according to sponsors of the show. Already more than 400 exhibitors have taken space, and the problem of finding places to accomodate new exhibitors planning to come in this year is a real one, the committee in charge states.

From reservations made so far, it is apparent that the tendency to show larger and heavier units is receiving a decided impetus this year. Many manufacturers plan to show their heavier machines in actual operation. In line with this coal-burning and handling machinery will be prominently featured. Boilers of the most modern type will be visualized in unique ways, and there will be a particularly strong representation of high-pressure steam specialties and instruments.

The first day of December marks the opening of the show, which will remain open for inspections the entire week to Dec. 6, running concurrently with the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers. Since the National Power Show will not be held in 1931, this forthcoming exhibition is expected to draw a record attendance.

New Swiss Steam Turbine for Anaconda Plant

A steam turbine with normal and maximum outputs of 20,000 kw. and 25,000 kw. respectively, has just been completed by Escher Wyss & Company of Zurich, Switzerland, for the Anaconda Copper Company's plant in Tocopilla, Chile. The machine has been designed as a single-casing turbine for coupling direct to a Siemens-Schuckert three-phase generator. The initial steam conditions are 200 lb. per square inch at a temperature of 650 deg. F. New boilers will be erected later, and the steam pressure and temperature will then be raised to 400 lb. and 725 deg. F., respectively. The vacuum at full load amounts to about 95 per cent.

El Paso Workers Celebrate Amazing Safety Record

Employees in the power plant department of the El Paso Electric Company, El Paso, Texas, established a remarkable safety record recently and the event was celebrated by a dinner at Hotel Hussmann. Besides members of the power plant personnel, President F. J. Gannon, with other company officials, and a few invited guests attended, a total of about 85 in all being present.

A. C. Learmonth, chief engineer of the power plant department, acted as toastmaster. Mr. Learmonth in announcing the purpose of the dinner stated that during the preceding 415 days, the 74 employees in his department worked a total of 245,860 man-hours without a chargeable or loss-time accident. From this it will be seen that during that period each man in the department completed a round of 3,320 man-hours without having had any sort of an accident to mar the safety record. The record is all the more impressive because it was established during the erection of the new Rio Grande plant.

Midwest Power Exposition to Be Held in Coliseum

The entire Coliseum in Chicago will be used to house the power equipment exhibits for the Midwest Engineering & Power Exposition to be held Feb. 10-13, 1931. This building contains over 85,000 sq.ft. all on one main floor and is one of the largest and best known exhibit halls in the country.

Because of the diverse type of power equipment, the exhibit space has been divided into six general groups so that visitors will be able to more easily find the majority of exhibitors in any one group. The groupings include: fuel-burning equipment, steam-generating equipment, water treatment and hydraulic valves, pipe and steam specialties, heating, and miscellaneous power equipment including coal and ash handling, electrical apparatus, welding and lubricating. A résumé of the various kinds of equipment to be displayed would easily run over the hundred mark.

News of Canada

Conservatives not ready to discuss St. Lawrence project —To harness Sproat River— Boilers ordered for Churchill

THE new Conservative government in Canada is not prepared to resume immediately discussion with the United States on the proposed St. Lawrence waterway. This was disclosed Sept. 15 when the State Department made public the recent exchange of notes between American Minister MacNider and Prime Minister Bennett.

In his note, under date of Sept. 2, Mr. MacNider advised the Canadian Prime Minister that the United States was ready to proceed with the proposed St. Lawrence waterway development at the earliest possible date, and asked whether Canada was in position to appoint commissioners to discuss the matter jointly with United States commissioners and formulate a treaty.

Replying, Prime Minister Bennett stated the Canadian Government had given consideration to some phases of the St. Lawrence waterway project, but in view of the fact that the Canadian Parliament is not in session and the Imperial Conference will meet in London, Sept. 30, it would not be possible to deal with the question in a comprehensive way until he returned in November.

THE British Columbia Power Corporation, through its subsidiary, known as the National Utilities Corporation, is proceeding with a scheme for harness-

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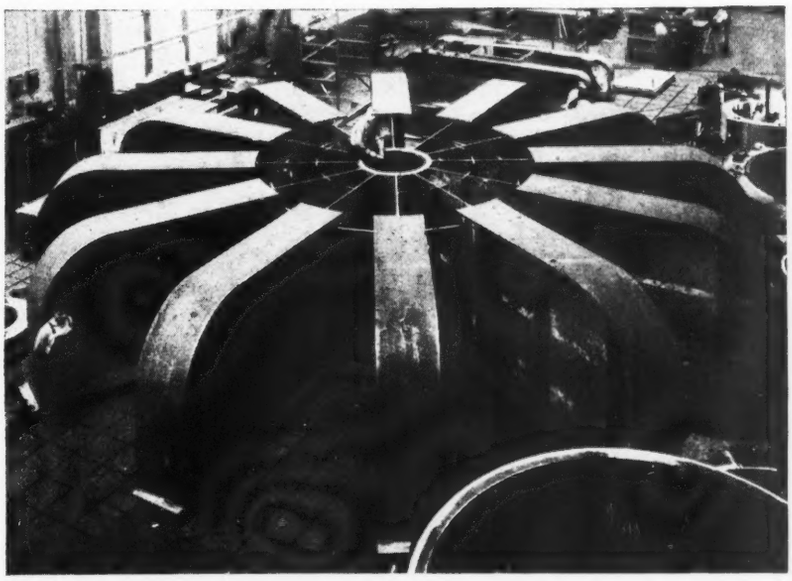
BUILDING THE WORLD'S LARGEST



The big thrust-bearing bracket of an 84,000-hp. hydro-electric generator, under construction at the Schenectady works of the General Electric Company for the Dneiper River station in Russia. The complete unit will have a total weight of 1,750,000 lb., this bracket alone weighing 235,000 pounds

ing the power at Sproat River, near Port Alberni, on the west coast of Vancouver Island. The initial scheme calls for the production of only 1,000 hp., but this is likely to be greatly increased in subsequent years as demand for electrical energy grows in that district. The company is seeking the right to divert 400 cu.ft. per second from the river, with a storage of 34,000 acre-ft. The point of diversion will be 200 ft. above the place where the Great Central highway bridge crosses the Sproat River. A dam will be erected there to impound the water.

IMPORTANT CONTRACTS in connection with the power equipment for the 2,500,000-bushel elevator the Canadian Department of Railways and Canals is constructing at Churchill, Hudson Bay Railway terminus, have been announced. The boiler house equipment will be supplied and installed by Babcock-Wilcox and Goldie McCulloch, Ltd., of Galt, Ont., and the generator room equipment by the C. A. Parsons Company, of Toronto and Newcastle-on-Tyne, England. The expenditure represented by these contracts will amount to about $550,000.

Ohio Power Companies Ask Right to Merge

The merger of five electric companies and the electric business of two interurban railway companies into the Central Ohio Light & Power Company, of Findlay, is sought in applications filed Sept. 10 with the Public Utilities Commission of Ohio. The aggregate purchase price is $5,234,900.

The companies to be acquired by the Central Ohio and the amount of cash each is to receive, according to signed agreements submitted to the commission, are as follows: Wooster Electric Company, $1,085,000; North Baltimore Service Company, $97,800; Rudolph Light & Power Company, $11,500; Farmers' Light & Power Company, of Venedocia, $90,300; Enterprise Utilities Company, $64,900; electric power and light business of the Toledo, Bowling Green & Southern Traction Company, $2,148,900, and of the Western Ohio Railway & Power Company, $1,736,500.

Dredging C. & O. Canal

Dredging is now going on in the old Chesapeake & Ohio Canal for the purpose of speeding up the current serving the turbines of hydro-electric plants in Georgetown, D. C. Sand bars and weed growths have been undisturbed since the abandonment of the use of the canal for commercial purposes in 1924. Dredges are now working between Key and Chain bridges, and have progressed 500 ft. up the river from the latter structure. Plans for the canal include deepening of the channel around the up-river locks.

COMING CONVENTIONS

American Society of Mechanical Engineers. Fall meeting at French Lick Springs, Ind., Oct. 13-17. National Wood Industries Division. Meeting at the Hotel Pennsylvania, New York City, Oct. 16-17. National Petroleum Meeting at Tulsa, Okla., Oct. 6-8. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Administrative board meeting at the Mayflower Hotel, Washington, D. C., Oct. 17-18. Secretary, L. W. Wallace, 26 Jackson Pl., Washington, D. C.

American Institute of Electrical Engineers. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

Midwest Power Engineering Conference and Exposition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Association of Purchasing Agents. District convention at the William Penn Hotel, Pittsburgh, Pa., Oct. 16-17. Secretary, A. D. Feeman, Superior Steel Corporation, Carnegie, Pa.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

New England Water Works Association. Annual convention at Haddon Hall, Atlantic City, N. J., Sept. 23-26. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Society of Industrial Engineers. Seventeenth national convention at the Mayflower Hotel, Washington, D. C., Oct. 15-17. Secretary, George C. Dent, 205 West Wacker Drive, Chicago, Ill.

Frank R. Ford Dies

Frank Richards Ford, a founder and member of the consulting engineering firm of Ford, Bacon & Davis, of New York City, died Sept. 17 in the Presbyterian Hospital, New York, following an operation.

Mr. Ford was born in Philadelphia in 1871 and was graduated from the University of Pennsylvania in 1890 with the B.S. and M.E. degrees. He spent several years in public utility and industrial engineering and in 1894 founded the consulting engineering firm of which he was a member at the time of his death.

Personals

C. A. DOBSON, chief engineer of the Brookside Mills, Knoxville, Tenn., was elected president of the National Association of Power Engineers at its recent annual convention in Cleveland, Ohio. Other officers elected include LISLE A. PIERSON of Detroit, Mich., vice-president; FRED W. RAVEN of Chicago, Ill., secretary; and SAMUEL B. FORSE of Pittsburgh, Pa., treasurer. The new officers announced that the next convention of the association will be held in Kansas City, Mo.

N. G. REINICKER, general manager of the Pennsylvania Power & Light Company, has been elected president of the Pennsylvania Electric Association. Mr. Reinicker was formerly engaged in the operation, maintenance, design and construction of steam-electric power stations with the Detroit Edison Company and other public utility companies.

FRANK S. CLARK, consulting engineer of the Stone & Webster Engineering Corporation, has just returned from an extended visit to Europe. Mr. Clark attended the World Power Conference and then visited several European countries to study recent power developments.

R. A. LANGWORTHY was recently elected vice-president of Dwight P. Robinson & Company, Inc., a division of United Engineers & Constructors, Inc. Mr. Langworthy has been connected with the Robinson company since its foundation, and for the past several years has been a member of the new business department.

T. CHALKLEY HATTON, consulting engineer, has been nominated for president of the Engineers' Society of Milwaukee for the year 1930-31. Other nominations include: For vice-president, MAX ROTTER, vice-president in charge of engineering of the Busch-Sulzer Bros. Diesel Engine Company; for treasurer, WALTER R. MEULLER; and for secretary, HUGO W. ROHDE. The annual election of the society will be held on Oct. 15.

JOHN V. STRANGE, vice-president of the Carolina Power & Light Company since Sept., 1928, has resigned to become vice-president and general manager of the United Gas Distribution Company, of Houston, Texas. A successor to Mr. Strange has not yet been named. Mr. Strange went to Raleigh from Portland, Ore., in 1924 to become operating manager of the Carolina company. In Oregon he was assistant general manager of the Pacific Power & Light Company.

R. E. FISHER, vice-president of the Pacific Gas & Electric Company, was elected president of the Pacific Coast Gas Association at its recent annual convention held in Pasadena.

Business Notes

LINK-BELT COMPANY, Chicago, Ill., has appointed B. H. MacNeal Southern district manager of its crane-shovel-dragline division. With headquarters at the company's Birmingham, Ala., office, Mr. MacNeal will have charge of the territory between the Mississippi Valley and the East Coast, south of and including the states of Tennessee and North Carolina.

ELLIOTT COMPANY, Jeannette, Pa., announces that F. S. B. Heward has severed his connection with the Affiliated Engineering Companies, Ltd., of Montreal and Quebec, Canada, and has organized his own company to be known as F. S. B. Heward & Company, Ltd. With officers at the New Birks Building, Montreal, and the Colonial Building, Toronto, the new company will handle the accounts of Elliott Company and associates.

ROLLER-SMITH COMPANY, New York City, announces the appointment of J. K. Webb, 601 Allen Building, Dallas, Texas, as its district sales agent for the state of Texas.

STEPHENS-ADAMSON MANUFACTURING COMPANY, Aurora, Ill., announces the appointment of Gordon F. Daggett as manager of its Wisconsin territory, with offices at 735 East Briarwood Pl., Milwaukee, Wis. Mr. Daggett will be responsible in his territory for both engineering and sales of the company's complete line of conveyors, screens and variable-speed transmissions.

E. F. HOUGHTON & COMPANY, Philadelphia, Pa., announces that its second vice-president and general sales manager, George W. Pressell, is spending six weeks visiting the Middle Western and Pacific Coast branches of the company.

PAIGE & JONES CHEMICAL COMPANY, Hammond, Ind., announces that it has sold to the PERMUTIT COMPANY the Zeolite and lime soda water-softening and filter departments of its business, including machinery, inventories, patterns and drawings relating thereto. It has been manufacturing water-softening apparatus as licensee under the Permutit patents, but will now devote its entire attention to the chemical branch of its business. The Permutit Company will furnish repair parts and replacements for Paige-Jones mechanical equipment now in use.

A. M. BYERS COMPANY, Pittsburgh, Pa., announces the appointment of M. J. Czarniecki to the newly created position of manager of tubular sales. Departmentalizing sales activities, the announcement states, was necessitated by the proposed expansion program of the company to broaden the markets for the use of wrought-iron in forms other than pipe.

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Hows Business?

THERE is no longer any doubt that the resistance level of this depression was reached some time in August. The only question now is as to the speed, vigor and permanence of the recovery during the remainder of this year. There are but six more weeks to go to the peak of the fall seasonal movement. This hill has to be taken on high to short-cut a stretch of rough and slow going this winter. The get-away so far in September has been somewhat slow, but the first two weeks have shown slightly more than seasonal improvement. After getting past the holiday drag, our preliminary index for the week ending Sept. 13 turned upward from 83.3% of normal to 84.3%. Basic industrial activity is increasing slowly, building projects are somewhat more active, primary distribution and general trade are showing fair seasonal expansion, commodity prices are definitely settling into stability, preparing for an upturn as forward buying becomes more active. — *The Business Week, Sept. 24.*

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Trade Catalogs

EQUIPMENT — Catalog GEA - 1248, A. C. network equipment; No. GEA-1201, herringbone gears; No. GEA-722-B, Selsyn motors; No. GEA-1280, centrifugal compressors; No. GEA-1151-A, mercury-arc rectifiers for railway service; No. 544-A, dynamometers; No. 1185, electric laboratory apparatus and education service; General Electric Company, Schenectady, N. Y.

INSTRUMENTS—Catalog No. 21, electric flow meters; No. 7501, indicating and recording remote-type instruments; Bulletin 7520, De Florez remote manual control system; Brown Instrument Company 4504 Wayne Ave., Philadelphia, Pa.

STEAM SPECIALTIES — Bulletin No. 293, capacity charts for Fisher specialties, Fisher Governor Company, Marshalltown, Iowa.

CONVEYORS—Catalog No. 100, Hahn steam jet conveyors, Treadwell Engineering Company, Hahn Division, Easton, Pa.

STOKERS—Catalog No. 201, single retort stokers, Detroit Stoker Company, General Motors Bldg., Detroit, Mich.

DUST HANDLING — Catalog 730, Hydrovac dust handling, Allen-Sherman-Hoff Company, 227 South 15th St., Philadelphia, Pa.

PUMPS—Bulletins No. 14 and 16, centrifugal pumps, Chicago Pump Company, 2336 Wolfram St., Chicago, Ill.

EQUIPMENT—Circular 1887, flexible couplings; No. 1891, speed reducers; Bulletin No. 14, automatic arc welding data; Circular 1892, metal enclosed truck-type switchgear; Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

BOILERS—Bulletin WB-30-2, waste heat boilers, Foster Wheeler Corporation, 165 Broadway, New York City.

MATERIAL HANDLING—Catalog, "The Barber Greene Line." Barber-Greene Company, 521 West Park Ave., Aurora, Ill.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard...	New York.....	$2.25 @$2.50
Kanawha.....	Cincinnati.....	1.10 @ 1.35
Smokeless.....	Cincinnati.....	1.85 @ 2.00
Smokeless.....	Chicago.....	1.75 @ 2.00
West Kentucky...	Louisville	.85 @ 1.25
Steam.....	Pittsburgh.....	1.30 @ 1.60
Gas Slack.....	Pittsburgh.....	1.00 @ 1.10
Big Seam.....	Birmingham....	1.60 @ 1.75
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York.....	$3.00 @$3.50
Barley.....	New York.....	1.25 @ 1.50

FUEL OIL

New York—Sept. 18, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—Sept. 11, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.420 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg. $1.620 per bbl.; 32@36 deg., gas oil, 3.776c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

Pittsburgh — Sept. 16, f.o.b. local refinery, 34@36 deg., fuel oil, 3.5c. per gal.; 36@40 deg., 3.5c.

Philadelphia—Sept. 16, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Sept. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Sept. 10, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 87.5c. per bbl.

Boston—Sept. 15, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.5c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Sept. 13, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ill., Mascoutah—American Telegraph & Telephone Co., 829 Telephone Bldg., St. Louis, Mo., awarded contract for a 1 story, 60 x 90 ft. telephone booster station to Hiram Lloyd Building & Construction Co., Syndicate Trust Bldg., St. Louis. Estimated cost $60,000. Booster and repeater boards, gas pressure system for cable lines, etc., will be installed. Owner also plans similar stations in Edwardsville, Jewett and Vandalia, Ill. Total cost $185,000; 175 mi. cable line from Terre Haute, Ind., to St. Louis, Mo., of which 30 mi. will be placed underground and balance aerial cable line will include 200 circuits. $3,000,000.

Ia., Burlington—Citizens Water Co., F. D. Lawler, Supt., is having preliminary surveys made for the construction of a new pumping station and equipment, $19,860, in connection with waterworks.

Kan., Kansas City — City will receive bids about Sept. 24 for extensions and improvements to power and light plant to include open and closed heaters, reducing valve and superheaters. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., are engineers.

Kan., Leavenworth—St. Mary's Academy, c/o Sisters of Charity, will build a boiler house and smokestack, 155 ft. high for academy. Work will be done by day labor under the supervision of M. Carroll and C. E. Dean, 713 Linwood Blvd., Kansas City, Mo., Engrs.

Mass., Fall River—Fall River Electric Light Co., R. F. Whitney, Mgr., North Main St., awarded contract for the construction of a substation at Fenner & Dwelly Sts., to New England Power Construction Co., 89 Broad St., Boston. Estimated cost $60,000.

Mass., Salem—Salem Electric Lighting Co., 205 Washington St., awarded contract for the construction of a coal handling plant and equipment at 25 Peabody St., to G. P. Carver, Inc., 40 Central St., Boston. Estimated cost $40,000.

Mo., St. Louis—Terminal Railroad Association, 1800 Market St., and St. Louis Mart Inc., lessee, c/o H. C. Martin, 315 North 10th St., will receive bids about Oct. 10 for the construction of an 8 story merchandise mart at 12th, Spruce, 13th and Poplar Sts. Estimated cost $5,000,000. W. J. Knight & Co., Wainwright Bldg., are engineers. Contracts let for excavation and reinforced concrete piles for footing, etc.

Mass., Springfield—United Electric Light Co., State St., awarded contract for the construction of a coal handling plant to Adams & Ruxton, 1387 Main St. Estimated cost $40,000.

Mass., Waltham — Middlesex College of Medicine & Surgery, H. S. Card, 473 Beacon St., will build a 4 story dormitory and power plant on South St. Estimated cost $40,000. Work will be done by separate contracts under the supervision of Leo Schlick Engineering Co., 314 Beacon St., Boston, Engr.

Minn., South St. Paul—City plans the construction of a sewage pumping station. Estimated cost $50,000. P. R. Banister, North St. Paul, is engineer.

Neb., Omaha—Home for Deaf, c/o O. R. Shafto, Secy., State Bd. of Control, awarded contract for the construction of a 1 story power plant to John Lof & Son, 2012 Lake St. Estimated cost $40,000.

N. J., Jersey City—Bd. of Commissioners, G. V. O'Hanlon, Supt., City Hall, received lowest bid for addition to hospital power house, laundry, etc., at Baldwin and Montgomery Sts., from Dalton-Millamet Co., 30 Church St., New York, $361,800.

N. J., Newark — Eighty Nine Clinton Ave. Corp., L. E. Goldfarb, c/o F. Grad, 1023 Broad St., Archt., is having plans prepared for the construction of a 20 story hotel and garage, including steam heating and ventilation systems, boilers, elevators, etc., at 75-89 Clinton Ave. Estimated cost $1,000,000.

N. J., Paterson—Public Service Electric & Gas Co., 80 Park Pl., Newark, awarded contract for the construction of a 1 story, 98 x 235 ft. electric sub-station at Prospect and Van Houten Sts., to United Engineers & Constructors, Inc., 870 Main Ave., Passaic. Estimated cost $100,000.

N. Y., Brooklyn—Ice Palace Corp., 393 7th Ave., New York, plans the construction of an ice skating pavilion at 588 Flatbush Ave. E. C. Horn & Sons, 1476 Broadway, New York, are architects. M. R. Carpenter, 176 West Adams St., Chicago, is engineer.

N. Y., Brooklyn — Paramount Ice Co., 241 Ellery St., awarded contract for the construction of a 100 x 150 ft. ice manufacturing plant at Steuben St. and Myrtle Ave. to William Werner & Son, 110 Hale Ave. Estimated cost $60,000.

N. Y., Rockaway Beach—Dept. of Hospitals, Municipal Bldg., New York, will receive bids about Oct. 25 for the construction of hospital buildings, including power house, etc., at Beach 149th St., here. Estimated cost $400,000. M. Bernstein, 1536 39th St., Brooklyn, is architect.

N. C., Wilson — City awarded contract for addition to power plant to Beaman & Coleman Construction Co., Lawyers Bldg., Raleigh. Estimated cost $16,360.

Texas — Central Power & Light Co., Frost Bldg., San Antonio, has made application to Federal Power Commission for permit to construct a hydro-electric plant on the Guadalupe River between Victoria and Cuero. Estimated cost $2,000,000. Private plans: also has work under way for waterworks and distribution systems, including deep well, 350 g.p.m. pumping unit, extension of oil field inside and outside city limits, etc. at Pettus, $30,000. Private plans. Most of work being done by day labor.

Tex., Schertz—U. S. Government, c/o A. W. Parker, Constructing Quartermaster, San Antonio, will receive bids about Sept. 25 for the construction of a post exchange building, including cold storage plant, etc., at Randolph Field, 14 mi. north of San Antonio. R. B. Kelly, 336 Milan Bldg., San Antonio, Estimated cost $50,000. Matthews & Kenan, Smith-Houng Tower, San Antonio, are consulting engineers.

Wis., Milwaukee — Bd. of Normal School Regents, Madison, is having plans prepared for the construction of a 2 story, 100 x 170 ft. and 50 x 90 ft. gymnasium, field house and power plant at State Normal School here. Estimated cost $250,000. A. Peabody, Madison, is architect.

Man., Churchill—Dept. of Railways & Canals, Ottawa, Ont., awarded contract for boiler house equipment to Babcock-Wilcox and Goldie McCulloch, Ltd., Galt, and generator room equipment to C. A. Parsons Co. Ltd., Royal Bank Bldg., Toronto, for 2,500,000 bu. grain elevator, $550,000.

Que., Montreal — Montreal Tramway Co., awarded contract for the construction of a 47 x 60 ft. sub-station on Queen Mary Rd., to I. J. MacGregor Ltd., 720 Castle Bldg. Estimated cost $33,000.

T. H., Pearl Harbor — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 5 for the construction of a refrigeration plant at Naval Operating Base here.

Equipment Wanted

Generating Units—Wells, Minn.—City will receive bids until Sept. 26 for three Diesel engine generating units, switchboard, etc., for electric light and power plant. Estimated cost $25,000.

Pump—Glendora, Calif.—City, F. Long, Clk., will receive bids until Sept. 30 for furnishing and installing a new pump head with underground discharge to be attached to present discharge column head, including motor, air gauge, oil cups, and fittings for proposed waterworks project.

Pump—Mountain Grove, Mo.—City plans to purchase new pump, etc., for proposed waterworks improvements. Estimated cost $20,000.

Pump, etc.—Washington, D. C.—A. L. Flint, General Purchasing Officer of the Panama Canal, will receive bids until Sept. 26 for duplex pump, etc., also until Oct. 3 for electric detonators.

Pumps—Waltham, Mass. (Boston P. O.)—City, H. F. Beal, Supt. of Public Works, is receiving bids for pumps, etc. for proposed waterworks improvements. Estimated cost $50,000.

Regulator, Exciters, etc.—Woodville, Miss.—Bd. of Aldermen, will receive bids until Oct. 7 for one voltage regulator for 180 kva. alternator, 2,300 v. with exciter, 15 kw., 125 kva. 275 r.p.m.; one 90 kva. alternator exciter 7½ kw., 1,400 r.p.m. shunt wound, one 47½ kw. alternator exciter 5 kw., 1,400 r.p.m. shunt wound.

Industrial Projects

Colorado—International Paper Co., 220 East 42nd St., New York, N. Y., is having preliminary surveys made for the construction of a paper mill at Pueblo, Salida or Alamosa, Colo. Estimated cost $2,500,000 to $5,000,000.

Ind., Fort Wayne — General Electric Co., awarded contract for the construction of a 50 x 80 ft. boiler plant on Winter St., to Buesching & Hagerman Co., 402 Superior St. Estimated cost $43,000. Equipment including 150 ft. chimney will be required.

Ind., Hammond — Hammond Lead Products Co., awarded contract for the construction of a factory at 1200 Standard Ave., to F. C. Rowley, 611 Hohman St. Estimated cost $100,000.

Ind., Terre Haute—American Can Co., will build a 3 story, 180 x 350 ft. factory, including boiler house and equipment. Estimated cost $1,000,000. Work will be done by separate contracts.

La., Harvey—Penick & Ford Ltd., awarded contract for the construction of a 117 x 117 ft. factory and cold storage plant, to G. J. Glover Co., Inc., Whitney Bank Bldg., New Orleans, $50,000.

Me., Peru—Berst-Forster Dixfield Co., manufacturers of wood products, awarded contract a 1 story, 100 x 146 ft. factory to J. H. Kerr, Rumford. Estimated cost $40,000.

Mass., Dighton—Anchor Color & Gum Works, awarded contract for the construction of a power plant to Theodore I. Ellis, 20 Alfred Stone Rd., Providence, R. I. Estimated cost $42,000.

Mass., Hyde Park (Boston P. O.) — Condit Electric Mfg. Co., 344 Hyde Park Ave., awarded contract for addition and alterations to factory, to C. A. Dodge Co., 2 Erie St., Cambridge. Estimated cost $50,000.

Mich., Detroit—C. W. Brandt, Francis Palms Bldg., Archt., is receiving bids for the construction of a 1 story, 40 x 300 ft. aluminum parts factory on Joseph Campau Ave. for Bohn Aluminum & Brass Co., 2512 East Grand Blvd. Estimated cost $45,000. Electric motors, etc., will be required.

N. J., Camden—Francesco & Jacobus, 511 5th Ave., New York, Archts. and Engrs., will receive bids about Sept. 25 for the construction of a 5 or 7 story, 129 x 339 ft. factory at Arch and Second Sts., here, for Continental Can Co., 1 Pershing Sq., New York. Estimated cost $1,000,000.

N. Y., Stapleton—Rubsam & Horrman Brewing Co., 191 Canal St., plans to rebuild brewery including refrigeration system recently destroyed by fire. Estimated cost to exceed $300,000.

O., Cincinnati—Boye & Emmes Machine Tool Co., 2245 Spring Grove Ave., awarded contract for the construction of a 1 story, 120 x 260 ft. factory at Caldwell Dr. here, also 1 story factory at Hartwell, to The Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $75,000 and $60,000 respectively.

O., Cleveland—Dobeckmun Co., T. F. Dolan, Pres., 1311 West 80th St. (machinery for the manufacture of Cellophane), awarded contract for a 1 story, 100 x 262 ft. factory on Monroe Ave. to William Dunbar Co., 8201 Cedar Ave. Estimated cost $75,000.

Pa., Bloomsburg—American Car & Foundry Co., 30 Church St., New York, plans to rebuild plant here, recently destroyed by fire. Estimated cost to exceed $150,000. Maturity indefinite.

Pa., Neville Island—Gulf Refining Co., Frick Bldg. Annex, Pittsburgh, will soon award contract for the construction of a boiler house as part of $1,500,000 project, here. E. B. Lee, Chamber of Commerce Bldg., Pittsburgh, is engineer.

Pa., Pittsburgh—Jones & Laughlin Steel Co., 3rd and Ross Sts., awarded contract for a 1 story, 16 x 47 ft. mill on 34th St., to Morgan Construction Co., 15 Belmont St., Worcester, Mass.

Ont., Fort William—Canadian Terminals System, Fort William, subsidiary of Canadian Terminals Systems, Ltd., 1106 Canadian Pacific Railroad Bldg., is having plans prepared for six main buildings and a low temperature carbonization process plant at River Front here. Estimated cost $400,000.

Ont., New Toronto — Anaconda American Brass Ltd., awarded masonry contract for a 1 story, 70 x 450 ft. and 98 x 200 ft. additions to plant. Estimated cost $200,000. Private plans.